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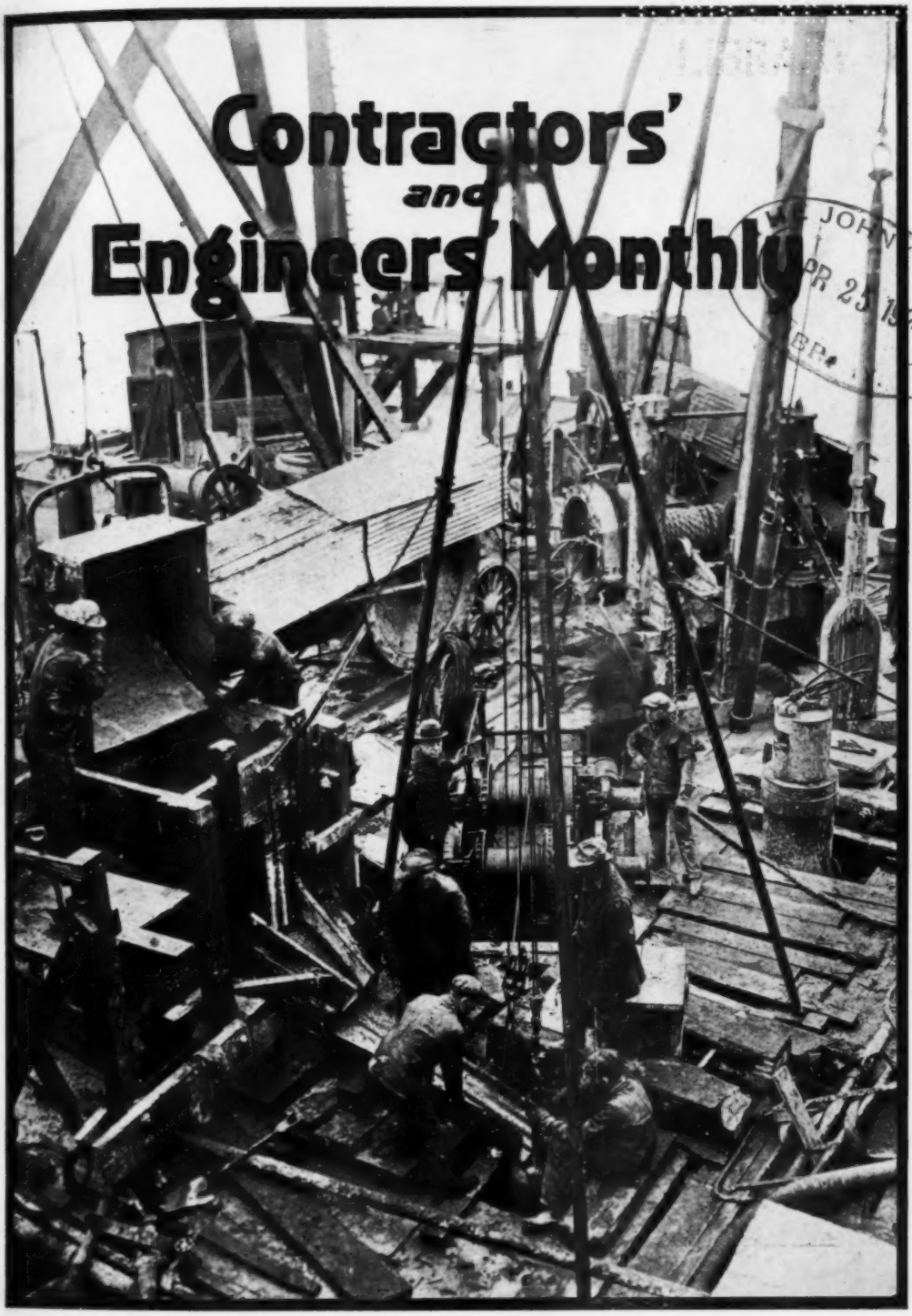
Contractors' and Engineers Monthly



Filling Reinforced Concrete Piles, South River Shaft, New Jersey
New York-New Jersey Vehicular Tunnel
See Pages 61-66 for Pictorial Story

APRIL, 1924 **25 Cents** **$1 a Year**

Vol. VIII. No. 4 CONTRACTORS' & ENGINEERS' MONTHLY April, 1924
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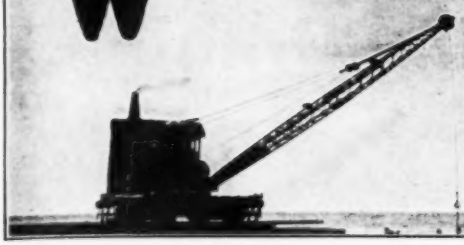
Where to Purchase



A comprehensive classification of the leading machinery and supply manufacturers arranged for the convenience of contractors, engineers and public officials who may wish to secure information about construction equipment. A star (*) before the manufacturer's name indicates that his advertisement appears in this issue.

ACETYLENE
Prest-O-Lite Co., Inc., New York.

ACETYLENE APPARATUS
Air Reduction Sales Co., New York.
Oxweld Acetylene Co., Newark, N. J.

ADDING MACHINES. **(See Calculating Machines.)**

AIR COMPRESSORS
*Domestic Engine & Pump Co., Shippensburg, Pa.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Chicago Pneumatic Tool Co., New York.
De Laval Steam Turbine Co., Trenton, N. J.
De La Vergne Machine Co., New York.
Fairbanks, Morse & Co., Chicago, Ill.
Gardner Governor Co., Quincy, Ill.
General Electric Co., Schenectady, N. Y.
Hardie-Tynes Mfg. Co., Birmingham, Ala.
Ingersoll-Rand Co., New York.
Nordberg Mfg. Co., Milwaukee, Wis.
Norwalk Iron Works Co., South Norwalk, Conn.
Schramm, Inc., West Chester, Pa.
Sullivan Mchy. Co., Chicago, Ill.
United Iron Works, Kansas City, Mo.
Westinghouse Trac. Brake Co., Wilmerding, Pa.
Worthington Pump & Mchy. Corp., New York.

ARC LAMPS
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., E. Pittsburgh, Pa.

ARTESIAN WELL DRILLS AND PUMPS
Am. Well Works, Aurora, Ill.

ASBESTOS PRODUCTS
*Carey Co., Philip, Cincinnati, Ohio.
Darcoid Co., Inc., New York.
Keasbey & Mattison Co., Ambler, Pa.
Mikesell Bros. Co., Wabash, Ind.
Norristown Mag. & Asb. Co., Norristown, Pa.
Sall Mountain Co., Chicago, Ill.

ASH HANDLING MACHINERY
*Haiss Mfg. Co., Geo., New York.
*International Motor Co., New York.
Bartlett & Snow Co., C. O., Cleveland O.
Bay City Dredge Wks., Bay City, Mich.
Brown Hoisting Mach. Co., Cleveland, Ohio.
Byers Mach. Co., Ravenna, Ohio.
Chain Belt Co., Milwaukee, Wis.
Gifford-Wood Co., Hudson, N. Y.
Green Eng. Co., East Chicago, Ind.
Guarantee Constr. Co., New York.
Jeffrey Mfg. Co., Columbus, Ohio.
Lakewood Eng. Co., Cleveland, O.
Link-Belt Co., Chicago, Ill.
Mead-Morrison Mfg. Co., E. Boston, Mass.
Portable Machinery Co., Passaic, N. J.
Robins Conv. Belt Co., New York.
Webster Mfg. Co., Chicago, Ill.
Weller Mfg. Co., Chicago, Ill.

ASPHALT PRODUCERS
*Barber Asphalt Co., Philadelphia, Pa.
*Barrett Co., New York
*Kentucky Rock Asphalt Co., Louisville, Ky.
*Standard Oil Co. (Indiana), Chicago, Ill.
*Texas Co., New York.
*Warren Bros. Co., Boston, Mass.
Atlantic Refining & Asphalt Corp., Phila., Pa.
Gulf Refining Co., Pittsburgh, Pa.
Headley Good Roads Co., Philadelphia, Pa.
New Orleans Refining Co., New Orleans, La.
Pioneer Asphalt Co., Lawrenceville, Ill.
Sinclair Ref. Co., Chicago, Ill.
Standard Oil Co. of Calif., San Francisco, Cal.
Standard Oil Co. of La., New Orleans, La.
Standard Oil Co. of N. J., Newark, N. J.
Standard Oil Co. of N. Y., New York.
U. S. Asphalt Refining Co., New York.

ASPHALT BLOCK
Hastings Pavement Co., New York.

ASPHALT CUTTERS
Dayton Pneumatic Tool Co., Dayton, Ohio.
Chicago Pneumatic Tool Co., New York
Ingersoll-Rand Co., New York.

ASPHALT KETTLES. **(See Kettles for Asphalt and Tar Heating.)**

ASPHALT PLANTS, TOOLS, ETC.
*Austin Machinery Corp'n, Toledo, O.
*Barber Asphalt Co., Philadelphia, Pa.
*East Iron & Machine Co., Lima, Ohio.
*Littleford Bros., Cincinnati, O.
*Warren Bros. Co., Boston, Mass.
Bacon Co., Edw. R., San Francisco, Cal.
Cummer & Son Co., F. D., Cleveland, O.
Hetherington & Berner, Indianapolis, Ind.

ASPHALT ROLLERS. **(See Road and Paving Rollers.)**

ASPHALT SURFACE HEATERS
*Barber Asphalt Co., Philadelphia, Pa.
*Equitable Asphalt Maint. Co., Kansas City, Mo.
Hauck Mfg. Co., Brooklyn, N. Y.

BACKFILLERS
*American Cement Mchy. Co., Inc., Keokuk, Ia.
*Austin Machinery Corp'n, Toledo, O.
*Koehring Co., Milwaukee, Wis.
*Pawling & Harnischfeger Co., Milwaukee, Wis.
Byers Machine Co., Ravenna, Ohio.
Constr. Mchy. Co., Waterloo, Ia.
Oshkosh Mfg. Co., Oshkosh, Wis.
Parsons Co., Newton, Ia.
Weller Mfg. Co., Chicago, Ill.

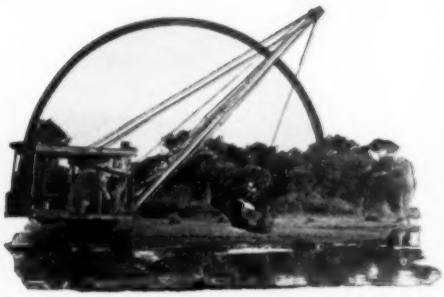
BAR BENDERS AND CUTTERS
*Koehring Co., Milwaukee, Wis.
*Ransome Concrete Mchy. Co., Dunellen, N. J.
Buffalo Forge Co., Buffalo, N. Y.
Concrete Steel Co., New York.
Electric Welding Co., Pittsburgh, Pa.
Hinman & Co., D. A., Sandwich, Ill.
McKenna Co., Cleveland, Ohio.

BAR CHAIRS, REINFORCING
*Truscon Steel Co., Youngstown, Ohio.
Concrete Steel Co., New York.
Universal Form Clamp Co., Chicago, Ill.

BARS, IRON AND STEEL
Ames & Co., W., Jersey City, N. J.
Bethlehem Steel Co., Bethlehem, Pa.
Carbon Steel Co., Pittsburgh, Pa.
Carnegie Steel Co., Pittsburgh, Pa.

KOEHRING

Gasoline Dragline



Action! Zippy Action!

CAST the bucket well out beyond the boom end! "Spot" it where you want it! Get a long haul! Pile the bucket up! There's a "whip" to the action of a Koehring that you'll get in no other Dragline—and it means a bigger day's work, every day. Sensitive control — easy control — even for a light operator — that's one of the secrets. No hard-pulling, man-killing levers. He shifts them with his fingers. It is that easy! Then there's the Koehring high line speed, another factor of bigger day's work.

And never forget that Koehring Heavy Duty Construction is working for you. It's your certainty of freedom from breakdowns, delays and heavy maintenance and depreciation — your insurance of longest service life.

Dragline Capacities

Designed strictly for internal combustion engine power.

No. 1 — ¾ cu. yd. Dragline Bucket on 35 ft. boom, or ½ cu. yd. Dragline Bucket on 40 ft. boom. Four cylinder 5" x 6". 1000 R.P.M. gasoline engine.

No. 2 — 1 cu. yd. Dragline Bucket on 40 ft. boom, or ¾ cu. yd. Dragline Bucket on 45 ft. boom. Four cylinder 5¾" x 7". 925 R. P. M. gasoline engine.

Electric starter if desired.

Why not write for the Koehring Dragline Bulletin No. 6.

KOEHRING COMPANY, MILWAUKEE, WIS.

PAVERS, MIXERS, CRANES, DRAGLINES, GASOLINE SHOVELS

SALES OFFICES AND SERVICE WAREHOUSES IN PRINCIPAL CITIES

Foreign Department—Room 1370, 50 Church St., New York City.
Canada—Koehring Company of Canada, Ltd., 105 Front Street, East, Toronto, Ontario.
Mexico—F. S. Lapum, Cinco De Mayo 21, Mexico, D. F

Franklin Steel Works, Franklin, Pa.
Gulf States Steel Co., Birmingham, Ala.
Hirsch Rolling Mill Co., St. Louis, Mo.
Illinois Steel Co., Chicago, Ill.
Inland Steel Co., Chicago, Ill.
Midvale Steel & Ordnance Co., Philadelphia, Pa.
Republic Iron & Steel Co., Youngstown, O.
St. Louis Screw Co., St. Louis, Mo.
Sweet's Steel Co., Williamsport, Pa.
Tenn. Coal, Iron & R. R. Co., Birmingham, Ala.
United Alloy Steel Corp., Canton, Ohio.

BATCH BOXES

Lakewood Eng. Co., Cleveland, O.
Western Wheeled Scraper Co., Aurora, Ill.

BELTING, RUBBER

*Goodrich Rubber Co., B. F., Akron, O.
*Robins Conv. Belt Co., New York.
Allen Mfg. Co., W. D., Chicago, Ill.
Cincinnati Rubber Mfg. Co., Cincinnati, Ohio.
Fairbanks Co., The, New York.
Goodall Rubber Co., Inc., Philadelphia, Pa.
Goodyear Tire & Rubber Co., Akron, O.
Mulconroy Co., Inc., Philadelphia, Pa.
Republic Rubber Co., Youngstown, Ohio.
Salisbury & Co., Inc., W. H., Chicago, Ill.
Southern Rubber & Belt. Co., Houston, Tex.
Union Asbestos & Rubber Co., Chicago, Ill.
U. S. Rubber Co, New York.
Voorhees Rubber Mfg. Co., Jersey City, N. J.

BINS, STORAGE

*Atlas Eng. Co., Milwaukee, Wis.
*Austin-Western Rd. Mach. Co., Chicago, Ill.
*Galion Iron Works & Mfg. Co., Galion, Ohio.
*Good Roads Mach'y Co., Kennett Square, Pa.
*Ransome Concrete Mach. Co., Dunnellen, N. J.
*Universal Road Machinery Co., Kingston, N. Y.
Austin Mfg. Co., Chicago, Ill.
Fairfield Engineering Co., Lancaster, Ohio.
Green Engineering Co., E. Chicago, Ind.
Link-Belt Co., Chicago, Ill.
Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa.
Weller Mfg. Co., Chicago, Ill.

BLAST HOLE DRILLING MACHINES. (See "Well Drilling and Blast Hole Machines")

BLASTING POWDER (See Explosives)

BLOCKS AND TACKLE

Boston & Lockport Block Co., East Boston, Mass.
Dobbie Fdry. & Mach. Co., Niagara Falls, N. Y.
Upson-Walton Co., Cleveland, Ohio.

BLOWERS, PRESSURE

American Blower Co., Detroit, Mich.
American Gas Furnace Co., New York.
Buffalo Forge Co., Buffalo, N. Y.
De Laval Steam Turbine Co., Trenton, N. J.
General Electric Co., Schenectady, N. Y.
Spencer Turbine Co., Hartford, Conn.
Sturtevant Co., B. F., Hyde Park, Boston, Mass.

BLOWPIPES

Oxweld Acetylene Co., Newark, N. J.

BLUE PRINT MACHINES

Dietzgen Co., Eugene, Chicago, Ill.
Keuffel & Esser Co., Hoboken, N. J.
Pease Co., C. F., Chicago, Ill.
Weber & Co., F., Philadelphia, Pa.
Wickes Bros., Saginaw, Mich.

BLUE PRINT AND TRACING PAPERS

Indianapolis Blue Print & S'ply Co., Ind'apolis.
Kolesch & Co., New York.

BOILERS

Abendroth & Root Mfg. Co., Newburgh, N. Y.
Ames Iron Works, Oswego, N. Y.
Babcock & Wilcox Co., New York.
Biggs Boiler Wks., Akron, Ohio.
Casey-Hedges Co., Chattanooga, Tenn.
Chandler & Taylor Co., Indianapolis, Ind.
Chatta. Boiler & Tank Co., Chattanooga, Tenn.
Cole Mfg. Co., R. D., Newnan, Ga.
Erie City Iron Works, Erie, Pa.
Flory Mfg. Co., S., Bangor, Pa.
Hartley Boiler Works, Montgomery, Ala.
Heine Boiler Co., St. Louis, Mo.
Houston, Stanwood & Gamble Co., Cincinnati, O.
Ladd Co., Geo. T., Pittsburgh, Pa.
Leffel & Co., J., Springfield, O.
Lord & Burnham Co., Irvington, N. Y.
Murray Iron Works Co., Burlington, Ia.
New Bern Iron Wks. & Sup. Co., New Bern, N. C.
Petroleum Iron Works Co., Sharon, Pa.
Schofield Iron Works, Macon, Ga.
Traylor Engr. & Mfg. Co., Allentown, Pa.
Valk & Murdoch Co., Charleston, S. C.
Vogt Mchy. Co., Inc., Louisville, Ky.
Walsh & Weidner Boiler Co., Chattanooga, Tenn.

BOLTS, NUTS, NAILS, RIVETS, SPIKES

American Screw Co., Providence, R. I.
American Spike Co., New York.
Ames, W. & Co., Jersey City, N. J.
Bethlehem Steel Co., Bethlehem, Pa.
Buffalo Bolt Co., Buffalo, N. Y.
Clark Bros. Bolt Co., Millidale, Conn.
Erie Bolt & Nut Co., Erie, Pa.
Foster Bolt & Nut Mfg. Co., Cleveland, Ohio.
Inland Steel Co., Chicago, Ill.
Lamson & Sessions Co., Cleveland, Ohio.
Maryland Bolt & Forge Co., Baltimore, Md.
Milton Mfg. Co., Milton, Pa.
Neely Nut & Bolt Co., Pittsburgh, Pa.
Oliver Iron & Steel Corp'n, Pittsburgh, Pa.
Pittsburgh Screw & Bolt Co., Pittsburgh, Pa.
Progressive Mfg. Co., Torrington, Conn.
Republic Iron & Steel Co., Youngstown, O.
Rhode Island Tool Co., Providence, R. I.
Russell, Burndall & Ward Co., Port Chester, N. Y
St. Louis Screw Co., St. Louis, Mo.
Scranton Bolt & Nut Co., Scranton, Pa.
Star Exp. Bolt Co., New York.
Sweet's Steel Co., Williamsport, Pa.

BRACES, TRENCH

Channon Mfg. Co., Jas. H., Chicago, Ill.
Duff Mfg. Co., Pittsburgh, Pa.
Kalamazoo Fdry. & Mach. Co., Kalamazoo, Mich.
Waldo Bros. & Bond Co., Boston, Mass.

BRASS GOODS

*Union Water Meter Co., Worcester, Mass.
Glauber Brass Mfg. Co., Cleveland, O.
Haydenville Co., Haydenville, Mass.
Hays Mfg. Co., Erie, Pa.
Mueller Company, Decatur, Ill.
United Brass Mfg. Co., Cleveland, O.

BREAKERS, CONCRETE

Buckeye Traction Ditcher Co., Findlay, O.
Chicago Pneumatic Tool Co., New York.
Ingersoll-Rand Co., New York City

BRICK, PAVING (See Paving Brick)

BRIDGES AND BUILDINGS, STEEL

*Blaw-Knox Co., Pittsburgh, Pa.
*Frederick Snare Corporation, New York.
American Bridge Co., New York.
Bellefontaine Bridge & Steel Co., Bellefontaine, O
Belmont Iron Works, Philadelphia, Pa.
Berlin Constr. Co., Berlin, Conn.
Bethlehem Steel Co., Bethlehem, Pa.
Boston Bridge Works, Boston, Mass.
Central States Bridge Co., Indianapolis, Ind.
Champion Bridge Co., Wilmington, O.
Chesapeake Iron Works, Baltimore, Md.
Chicago Bridge & Iron Works, Chicago, Ill.
Clinton Bridge Wks., Clinton, Iowa.
Eastern Bridge & Struc. Co., Worcester, Mass.
Flour City Orn. Iron Co., Minneapolis, Minn.
Fort Pitt Bridge Works, Pittsburgh, Pa.
Ingalls Iron Works Co., Birmingham, Ala.
Inter. Steel & Iron Co., Evansville, Ind.
Lewis-Hall Iron Wks., Detroit, Mich.
Louisville Bridge & Iron Co., Louisville, Ky
McClintic Marshall Co., Pittsburgh, Pa.
Milwaukee Bridge Co., Milwaukee, Wis.
Minn. Steel & Mchy. Co., Minneapolis, Minn.
Missouri Vy. Bdge. & Iron Co., Leavenworth, Kan.
Morava Constr. Co., Chicago, Ill.
Mt. Vernon Bridge Co., Mt. Vernon, Ohio.

Penn. Bridge Co., Beaver Falls, Pa.
Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa.
Richmond Struc. Steel Co., Richmond, Va.
Riverside Bridge Co., Martins Ferry, O.
Virginia Bridge & Iron Co., Roanoke, Va.
Wisc. Bridge & Iron Co., North Milwaukee, Wis.

BRONZE TABLETS

Flour City Orn. Iron Co., Minneapolis, Minn.
Imperial Brass Mfg. Co., Chicago, Ill.
Mott Iron Wks., J. L., New York

BROOMS (See Street Sweeping Brooms)

BUCKETS, AUTOMATIC DUMPING

*Littleford Bros., Cincinnati, O
Lakewood Engineering Co., Cleveland, O.
Stuebner Iron Works, G. L., Long Island City,

BUCKETS, CLAM SHELL

*Blaw-Knox Co., Pittsburgh, Pa.
*Haiss Mfg. Co., Geo., New York.
Brown Hoisting Mchy. Co., Cleveland, O.
Browning Co., Cleveland, O.
Byers Mach. Co., J. F., Ravenna, O.
Coleman Co., F. A., Cleveland, O.
Hayward Co., New York.
Industrial Works, Bay City, Mich.
Kiesler Co., J. F., Chicago, Ill.
Lakewood Engineering Co., Cleveland, O.
Link-Belt Co., Chicago, Ill.
Mead-Morrison Mfg. Co., E. Boston, Mass.
Orton & Steinbrenner Co., Chicago, Ill.
Owen Bucket Co., Cleveland, Ohio
Williams Co., G. H., Erie, Pa.

BUCKETS, CONCRETE

*Koppel Ind. Car & Equip. Co., Koppel, Pa.
*Ransome Concrete Mchy. Co., Dunellen, N. J.
Insley Mfg. Co., Indianapolis, Ind.
Lakewood Engineering Co., Cleveland, O.
Rochester Can Co., Rochester, N. Y.
Smith Co., T. L., Milwaukee, Wis.
Union Iron Works, Inc., Hoboken, N. J.
Weller Mfg. Co., Chicago, Ill.

BUCKETS, DRAGLINE

*Austin Machinery Corp'n, Toledo, O.
*Green, L. P., Chicago, Ill.
*Sauerman Bros., Chicago, Ill.
Brown Hoisting Mach. Co., Cleveland, O.
Bucyrus Co., So. Milwaukee, Wis.
Dobbie Fdry. & Mach. Co., Niagara Falls, N. Y.
Hayward Co., New York.
Industrial Works, Bay City, Mich.
Link-Belt Co., Chicago, Ill.
Monighan Machine Co., Chicago, Ill.

BUCKETS, DREDGING AND EXCAVATING

*Austin Machinery Corp'n, Toledo, O.
*Blaw-Knox Co., Pittsburgh, Pa.
*Haiss Mfg. Co., Inc., Geo., New York.
Brown Hoisting Mach. Co., Cleveland, O.
Browning Co., Cleveland, O.
Hayward Co., New York.
Kiesler Co., J. F., Chicago, Ill.
Lakewood Eng. Co., Cleveland, O.
Mead-Morrison Mfg. Co., East Boston, Mass.
Owen Bucket Co., Cleveland, Ohio.
Williams Co., G. H., Erie, Pa.

BUCKETS, ORANGE PEEL

Hayward Co., New York.
Industrial Works, Bay City, Mich.
Kiesler Co., J. F., Chicago, Ill.
McMyler Interstate Co., Cleveland, O.
Mead-Morrison Mfg. Co., East Boston, Mass.
Orton & Steinbrenner Co., Chicago, Ill.
Vulcan Iron Works, Jersey City, N. J.

BUILDERS' HARDWARE

Corbin, P. & F., New Britain, Conn.
Reading Hardware Co., Reading, Pa.
Russell & Erwin Mfg. Co., New Britain, Conn.
Sargent & Co., New Haven, Conn.
Stanley Works, New Britain, Conn.
Yale & Towne Mfg. Co., New York.

BUILDINGS, STEEL (See Bridges and Buildings)

BUNKS AND COTS

Fort Pitt Bedding Co., Pittsburgh, Pa.
Haggard & Marcusson Co., Chicago, Ill.
Southern Rome Co., Baltimore, Md.

CABLES (See Wire and Cables)

CABLEWAYS

*Green, L. P., Chicago, Ill.
*Sauerman Bros., Chicago, Ill.
*Street Bros. Mach. Wks., Chattanooga, Tenn.
Broderick & Bascom Rope Co., St. Louis, Mo.
Flory Mfg. Co., S., Bangor, Pa.
Lidgerwood Manufacturing Co., New York.
Mead-Morrison Mfg. Co., E. Boston, Mass.
Roebling Sons Co., J. A., Trenton, N. J.
Waterbury Co., New York.

CAISSONS

American Bridge Co., New York.
Foundation Co., New York.
Bethlehem Steel Co., Bethlehem, Pa.
O'Rourke Eng. Constr. Co., New York.
Petroleum Iron Works Co., Sharon, Pa.

CALCIUM CHLORIDE FOR ROADS

*Dow Chemical Co., Midland, Mich.
*Semet-Solvay Co., Syracuse, N. Y.
Carbondale Calcium Co., Carbondale, Pa.

CALCULATING MACHINES

Burroughs Adding Machine Co., Detroit, Mich.
Dalton Adding Mach. Co., Cincinnati, O.
Felt & Tarrant Mfg. Co., Chicago, Ill.
Marchant Calc. Machine Co., Oakland, Cal.
Monroe Calculating Machine Co., Orange, N. J.

CANS FOR GARBAGE AND STREET REFUSE

*Rochester Can Co., Rochester, N. Y.
American Can Co., New York.
Butler Mfg. Co., Minneapolis, Minn.
Economy Baler Co., Ann Arbor, Mich.
Solar-Sturges Mfg. Co., Chicago, Ill.
Steel Basket Co., Cedar Rapids, Iowa.

CARS, INDUSTRIAL V. DUMPING

*Austin Machinery Corp'n, Toledo, O.
*Insley Mfg. Co., Indianapolis, Ind.
*Koppel Ind. Car & Equip. Co., Koppel, Pa.
Atlas Car & Mfg. Co., Cleveland, O.
Chase Fdry. & Mfg. Co., Columbus, O.
Easton Car & Constr. Co., New York.
Hunt Co., C. W., W. New Brighton, N. Y.
Lakewood Engineering Co., Cleveland, O.
Stuebner Iron Works, G. L., L. I. City, N. Y.
United Iron Works, Kansas City, Mo.
Weller Mfg. Co., Chicago, Ill.
Whiting Corp'n, Harvey, Ill.

CARTS, CONCRETE

*Insley Mfg. Co., Indianapolis, Ind.
*Littleford Bros., Cincinnati, O.
*Ransome Concrete Mchy. Co., Dunellen, N. J.
Akron Barrow Co., Cleveland, Ohio.
Etnyre & Co., E. D., Oregon, Ill.
Gray Iron Fdry. Co., Reading, Pa.
Lakewood Engineering Co., Cleveland, O.
Lee Trailer & Body Co., Chicago, Ill.
Smith Co., T. L., Milwaukee, Wis.
Sterling Wheelbarrow Co., Milwaukee, Wis.
Toledo Wheelbarrow Co., Toledo, Ohio.

CAST IRON PIPE (See Pipe, Cast Iron)

CASTINGS, STREET AND SEWER

*Central Foundry Co., New York.
*Clark Co., H. W., Mattoon, Ill.
*U. S. Cast Iron Pipe & Fdry. Co., Burlington, N. J.
Canton Foundry & Machine Co., Canton, O.
Casey-Hedges Co., Chattanooga, Tenn.
Clow & Sons, J. B., Chicago, Ill.
Dee Co., W. E., Chicago, Ill.
Portable Machinery Co., Passaic, N. J.
Foundry Mfg. Co., St. Albans, Vt.

Klauer Mfg. Co., Dubuque, Iowa.
Madison Foundry Co., Cleveland, O.
Pechstein Iron Works, Keokuk, Ia.
Sessions Foundry Co., Bristol, Conn.
South Bend Foundry Co., South Bend, Ind.

CATCH BASINS (See Castings, Street and Sewer)

CATCH BASIN CLEANING APPARATUS
*International Motor Co., New York.
Elgin Sales Corp., New York.

CAULKING MACHINERY AND TOOLS
Helwig Mfg. Co., St. Paul, Minn.
Ingersoll-Rand Co., New York.
Mueller Company, Decatur, Ill.

CEILINGS, METAL
Berger Mfg. Co., Canton, O.
Canton Art Metal Co., Canton, O.
Newport Rolling Mill Co., Newport, Ky.
Klauer Mfg. Co., Dubuque, Iowa.
Mesker & Co., Geo. L., Evansville, Ind.
Milwaukee Corrugating Co., Milwaukee, Wis.
Wheeling Corrugating Co., Wheeling, W. Va.

CEMENT
*Pennsylvania Cement Co., New York
Ætna Portland Cement Co., Detroit, Mich.
Allentown Portland Cement Co., Allentown, Pa.
Alpha Portland Cement Co., Easton, Pa.
Ash Grove Lime and Portland Cement Co., Kansas City, Mo.
Atlas Portland Cement Co., New York.
Bath Portland Cement Co., Philadelphia, Pa.
Beaver Portland Cement Co., Portland, Ore.
Bessemer Limestone and Cement Co., Youngstown, O.
Bonner Portland Cement Co., Kansas City, Mo.
Canada Cement Co., Ltd., Montreal, Canada.
Cape Girardeau Portland Cement Co., Cape Girardeau, Mo.
Castalia Portland Cement Co., Pittsburgh, Pa.
Clinchfield Portland Cement Corp., Kingsport, Tenn.
Colorado Portland Cement Co., Denver, Colo.
Continental Portland Cement Co., St. Louis, Mo.
Coplay Cement Manufacturing Co., Coplay, Pa.
Cowell Portland Cement Co., San Francisco, Cal.
Crescent Portland Cement Co., Wampum, Pa.
Dewey Portland Cement Co., Kansas City, Mo.
Dexter Portland Cement Co., Nazareth, Pa.
Diamond Portland Cement Co., Cleveland, Ohio.
Dixie Portland Cement Co., Chattanooga, Tenn.
Edison Portland Cement Co., New York.
Fredonia Portland Cement Co., Fredonia, Kans.
Giant Portland Cement Co., Philadelphia, Pa.
Gilmore Portland Cement Corp., Gilmore City, Iowa.
Glens Falls Portland Cement Co., Glens Falls, N. Y.
Golden State Portland Cement Co., Los Angeles, Cal.
Gulf States Portland Cement Co., Demopolis, Ala.
Hawkeye Portland Cement Co., Des Moines, Ia.
Helderberg Cement Co., Albany, N. Y.
Hercules Cement Corp., Philadelphia, Pa.
Indiana Portland Cement Co., Indianapolis, Ind.
International Portland Cement Co., Ltd., Spokane, Wash.
Knickerbocker Portland Cement Co., Inc., New York.
Kosmos Portland Cement Co., Louisville, Ky.
Lawrence Portl'd Cement Co., Northampton, Pa.
Lehigh Portland Cement Co., Allentown, Pa.
Louisville Cement Co., Louisville, Ky.
Marquette Cement Mfg. Co., Chicago, Ill.
Missouri Portland Cement Co., St. Louis, Mo.
Monarch Cement Co., Humboldt, Kans.
Nazareth Cement Co., Nazareth, Pa.
Newaygo Portland Cement Co., Newaygo, Mich.
Nebraska Cement Co., Denver, Colo.
New Egyptian Portland Cement Co., Fenton, Mich.
New York & New England Cement & Lime Co., New York.
Northwestern States Portland Cement Co., Mason City, Ia.
Ogden Portland Cement Co., Ogden, Utah.
Oklahoma Portland Cement Co., Denver, Colo.
Old Mission Portland Cement Co., San Francisco, Cal.
Olympic Portl'd Cement Co., Ltd., Seattle, Wash.
Oregon Portland Cement Co., Portland, Ore.
Pacific Portland Cement Co., San Francisco, Cal.
Peerless Portland Cement Co., Union City, Mich.
Peninsular Portland Cement Co., Cement City, Mich.
Penn-Allen Cement Co., Allentown, Pa.
Petoskey Portland Cement Co., Petoskey, Mich.
Phœnix Portland Cement Co., Nazareth, Pa.
Portland Cement Co. of Utah, Salt Lake City, Utah.
Pyramid Portland Cement Co., Des Moines, Ia.
Riverside Portl'd Cement Co., Los Angeles, Cal.
San Antonio Portland Cement Co., San Antonio, Tex.
Sandusky Cement Co., Cleveland, Ohio.
Santa Cruz Portland Cement Co., San Francisco, Cal.
Security Cement and Lime Co., Hagerstown, Md.
Signal Mountain Portland Cement Co., Chattanooga, Tenn.
Southern States Portland Cement Co., Rockport, Ga.
Southwest'n Portland Cement Co., El Paso, Tex.
Standard Portland Cement Corp., San Francisco, Calif.
Superior Portland Cement Co., Seattle, Wash.
Texas Portland Cement Co., Dallas, Tex.
Three Forks Portland Cement Co., Denver, Colo.
Tidewater Portland Cement Co., Baltimore, Md.
Trinity Portland Cement Co., Dallas, Tex.
Union Portland Cement Co., Ogden, Utah.
United States Potash Co., Los Angeles, Cal.
U. S. Portland Cement Co., Denver, Colo.
Universal Portland Cement Co., Chicago, Ill.
Vulcanite Portland Cement Co., Philadelphia, Pa.
Wabash Portland Cement Co., Detroit, Mich.
Wellston Iron Furnace Co., Jackson, Ohio.
Western States Portland Cement Co., Independence, Kans.
Whitehall Cement Mfg. Co., Philadelphia, Pa.
Wolverine Portl'd Cement Co., Coldwater, Mich.
Wyandotte Portland Cement Co., Detroit, Mich.

CEMENT GUNS
Cement Gun Co., Allentown, Pa.

CEMENT INSPECTION (See Inspecting Laboratories)

CEMENT TOOLS
*Abrams Cement Tool Co., Detroit, Mich.

CHAINS
American Chain Co., Inc., Bridgeport, Conn.
Chain Belt Co., Milwaukee, Wis.
Columbus McKinnon Chain Co., Columbus, O.
Diamond Chain & Mfg. Co., Indianapolis, Ind.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Chicago, Ill.
Niagara Metal Stamp Corp., Niagara Falls, N. Y.
U. S. Chain & Forge Co., Pittsburgh, Pa.
Webster Mfg. Co., Chicago, Ill.
Weller Mfg. Co., Chicago, Ill.

CHEMICALS FOR WATER PURIFICATION
Du Pont de Nemours & Co., E. I., Wilmington, Del.
Electro Bleaching Gas Co., New York.
General Chemical Co., New York.
Arnold, Hoffman & Co., Inc., New York.
Hooker Electrochemical Co., New York.
Mathieson Alkali Works, Inc., New York.
Penna. Salt Mfg. Co., Philadelphia, Pa.

CHIMNEYS, CONCRETE
Heine Chimney Co., Chicago, Ill.
Rust Engineering Co., Pittsburgh, Pa.
Weber Chimney Co., Chicago, Ill.

CHIMNEYS, RADIAL BRICK
American Chimney Corp., New York
Custodis Chimney Const. Co., Alphons, New York.
Heine Chimney Co., Chicago, Ill.
Heinicke, Inc., H. R., Indianapolis, Ind.
Kellogg & Co., M. W., New York.
Rust Engineering Co., Pittsburgh, Pa.

CHIMNEYS, STEEL (See Stacks, Steel)

CHLORINATORS
*Wallace & Tiernan Co., Inc., Newark, N. J.

CHLORINE, LIQUID (See Liquid Chlorine)

CHUTES, CONCRETE
*Insley Mfg. Co., Indianapolis, Ind.
*Ransome Concrete Mchy. Co., Dunellen, N. J.
Lakewood Engineering Co., Cleveland, O.

CLIPS, WIRE ROPE
American Hoist & Derrick Co., St. Paul, Minn.
Marion Malleable Iron Works, Marion, Ind.
Mockbee & Co., C. M., Cincinnati, O.
Roebling Sons Co., J. A., Trenton, N. J.
Upson-Walton Co., Cleveland, O.

COAL AND ORE CONVEYING MACHINERY
*Good Roads Mach'y Co., Kennett Square, Pa.
*Haiss Mfg. Co., Geo., New York.
*Robins Conv. Belt Co., New York.
Barber-Greene Co., Aurora, Ill.
Bartlett & Snow Co., C. O., Cleveland, Ohio.
Brown Hoisting Mchy. Co., Cleveland, O.
Chain Belt Co., Milwaukee, Wis.
Fairfield Engineering Co., Lancaster, Ohio.
Gifford-Wood Co., Hudson, N. Y.
Hunt Co., Inc., C. W., West New Brighton, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Kon-Wald Co., Buffalo, N. Y.
Lidgerwood Mfg. Co., New York.
Link-Belt Co., Chicago, Ill.
Mead-Morrison Mfg. Co., E. Boston, Mass.
Portable Machinery Co., Passaic, N. J.
Webster Mfg. Co., Chicago, Ill.
Weller Mfg. Co., Chicago, Ill.

COCKS, CURB AND CORPORATION
*Union Water Meter Co., Worcester, Mass.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Glauber Brass Mfg. Co., Cleveland, O.
Haydenville Co., Haydenville, Mass.
Mueller Company, Decatur, Ill.

COLUMN CLAMPS
*Insley Mfg. Co., Indianapolis, Ind.
Sterling Wheelbarrow Co., Milwaukee, Wis.
Universal Form Clamp Co., Chicago, Ill.

COMPRESSORS, AIR (See Air Compressors)

CONCRETE FLOOR HARDENER
*Truscon Laboratories, Detroit, Mich.
Anti-Hydro Waterproofing Co., Newark, N. J.
General Chemical Co., New York.
General Fireproofing Co., Youngstown, Ohio.
Granitex Corp., New York.
Horn Co., A. C., Long Island City, N. Y.
Master Builders Co., Cleveland, O.
Sonneborn Sons, Inc., L., N. Y. "Lapidolith"

CONCRETE MIXERS
*American Cement Mchy. Co., Inc., Keokuk, Ia.
*Austin Machinery Corp'n, Toledo, O.
*Jaeger Machine Co., Columbus, O.
*Atlas Eng. Co., Milwaukee, Wis.
*Koehring Co., Milwaukee, Wis.
*Ransome Concrete Mchy. Co., Dunellen, N. J.
Badger Concrete Mixer Co., Milwaukee, Wis.
Chain Belt Co., Milwaukee, Wis.
Construction Mach'y Co., Waterloo, Iowa.
Contractors' Equipment Co., Keokuk, Ia.
Foote Concrete Mchy. Co., Chicago, Ill.
Gray Iron Fdry Co., Reading, Pa.
Judy Mfg. Co., Centerville, Ia.
Knickerbocker Co., Jackson, Mich.
Lakewood Engineering Co., Cleveland, O.
Lansing Co., Lansing, Mich.
Marsh-Capron Co., Chicago, Ill.
Milwaukee Concrete Mixer Co., Milwaukee, Wis.
Oshkosh Mfg. Co., Oshkosh, Wis.
Republic Iron Works, Tecumseh, Mich.
Schramm, Inc., West Chester, Pa.
Smith Co., T. L., Milwaukee, Wis.
Standard Scale & Supply Co., Pittsburgh, Pa.
Truckmixer Co., Milwaukee, Wis.
Worthington Pump & Mach'y Corp., New York.

CONCRETE PILING. (See Piling, Concrete)

CONCRETE REINFORCEMENT
*Truscon Steel Co., Youngstown, O.
*Wickwire Spencer Steel Corp., New York.
American Steel & Wire Co., Chicago, Ill.
Bethlehem Steel Co., Bethlehem, Pa.
Carnegie Steel Co., Pittsburgh, Pa.
Concrete Steel Co., New York.
Consolidated Expanded Metal Co., Braddock, Pa.
Electric Welding Co., Pittsburgh, Pa.
General Fireproofing Co., Youngstown, O.
Inland Steel Co., Chicago, Ill.
Kalman Steel Co., Chicago, Ill.
National Steel Fabric Co., Pittsburgh, Pa.
Ryerson & Son., J. T., Chicago, Ill.
Youngstown Pressed Steel Co., Warren, O.
Youngstown Sheet & Tube Co., Youngstown, O.

CONCRETE ROAD FINISHERS
*Dunn Road Mach. Co., Covington, Ohio.
French & Co., A. W., Chicago, Ill.
Heltzel Steel Form & Iron Co., Warren, O.
Lakewood Eng. Co., Cleveland, Ohio

CONCRETE TOOLS
*Dallett Co., The., Philadelphia, Pa.

CONDENSERS
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Dean Bros. Steam Pump Wks., Indianapolis, Ind.
Ingersoll-Rand Co., New York.
Westinghouse Elec. & Mfg. Co., E. Pittsb'gh, Pa.
Wheeler Condenser & Eng. Co., Carteret, N. J.
Worthington Pump & Mach'y Corp., New York.

CONDUIT RODS
Bissell Co., F., Toledo, Ohio.
Turbine Sewer Machine Co., Milwaukee, Wis.
Waldo Bros. & Bond Co., Boston, Mass.

CONDUITS, INTERIOR
American Circular Loom Co., New York.
Central Tube Co., Pittsburgh, Pa.
Clifton Mfg. Co., Boston, Mass.
Garland Mfg. Co., W. Pittsburgh, Pa.
National Enam. & Mfg. Co., Pittsburgh, Pa.
National Metal Molding Co., Pittsburgh, Pa.
Pittsburgh Steel Co., Beaver, Pa.
Sprague Electric Wks., New York
Steelduct Co., Youngstown, O.
Youngstown Sheet & Tube Co., Youngstown, O.

CONDUITS, UNDERGROUND
American Vitrified Products Co., Akron, Ohio.
Dickey Clay Mfg. Co., W. S., Kansas City, Mo.
Fibre Conduit Co., Orangeburg, N. Y.
Johns-Manville, Inc., New York.
National Fireproofing Co., New York.

CONTRACTORS' SUPPLY DEALERS
(See pages 103-119)

CONVEYORS, BELT
*Good Roads Mach'y Co., Kennett Square, Pa.
*Haiss Mfg. Co., Geo., New York.
*Russell Grader Mfg. Co., Minneapolis, Minn.
Barber-Greene Co., Aurora, Ill.
Chain Belt Co., Milwaukee, Wis.
Gifford Wood Co., Hudson, N. Y.
Goodyear Tire & Rubber Co., Akron, O.
Imperial Belting Co., Chicago, Ill.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Chicago, Ill.
Olson & Co., Sam'l, Chicago, Ill.
Portable Machinery Co., Passaic, N. J.
Republic Rubber Co., Youngstown, O.
Robins Conv. Belt Co., New York.
Standard Conveyor Co., No. St. Paul, Minn.
Webster Mfg. Co., Chicago, Ill.
Weller Mfg. Co., Chicago, Ill.

CONVEYORS, BUCKET
*Atlas Engineering Co., Milwaukee, Wis.

*Good Roads Mach'y Co., Kennett Square, Pa.
*Haiss Mfg. Co., Geo., New York.
*Russell Grader Mfg. Co., Minneapolis, Minn.
Bartlett & Snow Co., C. O., Cleveland, O.
Caldwell & Son, H. W., Chicago, Ill.
Chain Belt Co., Milwaukee, Wis.
Fairfield Engineering Co., Lancaster, Ohio.
Gifford Wood Co., Hudson, N. Y.
Godfrey Conveyor Co., Elkhart, Ind.
Guarantee Constn. Co., New York.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Chicago, Ill.
Mead-Morrison Mfg. Co., E. Boston, Mass.
Olson & Co., Sam'l, Chicago, Ill.
Republic Rubber Co., Youngstown, O.
Robins Conv. Belt Co., New York.
Stephens Adamson Mfg. Co., Aurora, Ill.
Webster Mfg. Co., Chicago, Ill.
Weller Mfg. Co., Chicago, Ill.

CONVEYORS, GRAVITY

Alvey-Ferguson Co., Cincinnati, O.
Dow Co., Louisville, Ky.
Lamson Co., Syracuse, N. Y.
Mathews Gravity Carrier Co., Elwood City, Pa.
Standard Conveyor Co., No. St. Paul, Minn.

CRANES, LOCOMOTIVE

*Koehring Co., Milwaukee, Wis.
*Osgood Co., The, Marion, O.
*Pawling & Harnischfeger Co., Milwaukee, Wis.
American Hoist & Derrick Co., St. Paul, Minn.
Brown Hoisting Mchy. Co., Cleveland, O.
Browning Co., Cleveland, O.
Bucyrus Co., South Milwaukee, Wis.
Byers Machine Co., Ravena, O.
Davenport Locomotive Works, Davenport, Ia.
Erie Steam Shovel Co., Erie, Pa.
Hanna Eng. Works, Chicago, Ill.
Industrial Works, Bay City, Mich.
Link-Belt Co., Chicago, Ill.
Locomotive Crane Co. of America, Champaign, Ill
Marion Steam Shovel Co., Marion, O.
McMyler Interstate Co., Cleveland, O.
Northwest Engineering Works, Chicago, Ill.
Orton & Steinbrenner Co., Chicago, Ill.
Ohio Locomotive Crane Co., Bucyrus, O.
Overland Crane Co., Hammond, Ind.
Thew Shovel Co., Lorain, O.
U. S. Crane Co., Chicago, Ill.

CRANES, OVERHEAD TRAVELING

*Pawling & Harnischfeger Co., Milwaukee, Wis.
Alliance Machine Co., Alliance, O.
Chesapeake Iron Wks., Baltimore, Md.
Champion Engineering Co., Kenton, O.
Milwaukee Electric Crane Co., Milwaukee, Wis.
Morgan Engineering Co., Alliance, O.
Northern Eng. Works, Detroit, Mich.
Shaw Crane Works, Muskegon, Mich.
Shepard Elec. Cr. & Hst. Co., Montour Falls, N.Y.
Toledo Crane Co., Bucyrus, O.
Whiting Fdry. & Equip. Co., Harvey, Ill.

CRANES, WRECKING

Bucyrus Co., South Milwaukee, Wis.
Industrial Works, Bay City, Mich.

CREOSOTED BLOCKS, TIMBER, ETC.

American Creosoting Co., Inc., New York.
American Creosote Works, Inc., N. Orleans, La.
Carter Bloxonend Flooring Co., Kansas City, Mo.
Colonial Creosoting Co., Inc., New York.
Georgia Creosoting Co., New York.
Jennison-Wright Co., Toledo, O.
Midland Creosoting Co., Granite City, Ill.
Republic Creosoting Co., Indianapolis, Ind.
Southern Wood Pres. Co., Atlanta, Ga.
Wyckoff Pipe & Creosoting Co., New York.

CREOSOTING AND CREOSOTING OILS

Am. Creosote Wks., Inc., New Orleans, La.
Barrett Co., New York.
Jennison-Wright Co., Toledo, O.
Southern Creosoting Co., Ltd., Slidell, La.
Southern Paving Const. Co., Chattanooga, Tenn.
Wyckoff Pipe & Creosoting Co., New York.

CRUSHERS, HEAVY DUTY

Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Buchanan Co., O. G., New York.
Traylor Eng. & Mfg. Co., Allentown, Pa.
Worthington Pump & Machy. Corp., New York.

CRUSHERS, ROCK

*Austin-Western Road Mach. Co., Chicago, Ill.
*Galion Iron Wks. & Mfg. Co., Galion, Ohio
*Good Roads Machinery Co., Kennett Square, Pa.
*Universal Road Machinery Co., Kingston, N. Y.
Acme Road Machy. Co., Frankfort, N. Y.
Case Threshing Mach. Co., J. I., Racine, Wis.
Chalmers & Williams, Chicago Hts., Ill.
Kennedy-Van Saun Mfg. & Eng. Corp., New York.
Lewistown Fdry. & Mach. Co., Lewistown, Pa.
McLanahan Stone Mach. Co., Hollidaysburg, Pa.
Morgan Engineering Co., Alliance, O.
New Holland Mach. Co., New Holland, Pa.
Smith Eng. Wks., Milwaukee, Wis.
Sturtevant Mill Co., Boston, Mass.
Universal Crusher Co., Cedar Rapids, Ia.

CULVERTS, CAST IRON

*U. S. C. I. Pipe & Fdry. Co., Burlington, N. J.
American Cast Iron Pipe Co., Birmingham, Ala.
Wood & Co., R. D., Philadelphia, Pa.

CULVERTS, CORRUGATED METAL

*Austin-Western Rd. Mach. Co., Chicago, Ill.
*Galion Iron Works & Mfg. Co., Galion, Ohio.
*Good Roads Machinery Co., Kennett Square, Pa.
*Newport Culvert Co., Newport, Ky.
Canton Culvert & Silo Co., Canton, O.
Dominion Metal Products Corp., Roanoke, Va.
Florida Metal Products Co., Jacksonville, Fla.
Hardesty Mfg. Co., The R., Denver, Colo.
Klauer Mfg. Co., Dubuque, Ia.
Lyle Culv. & Rd. Equip. Co., Minneapolis, Minn.
Southern Metal Culvert Co., Salisbury, N. C.
Wheeling Corrugating Co., Wheeling, W. Va.

CURB BOXES

*Clark Co., H. W., Mattoon, Ill.
Casey-Hedges Co., Chattanooga, Tenn.
Clow & Sons, J. B., Chicago, Ill.
Foundry Mfg. Co., St. Albans, Vt.
Madison Foundry Co., Cleveland, O.
Mueller Mfg. Co., Decatur, Ill.
Thompson-Fleming Co., Inc., Buffalo, N. Y.

CURB GUARDS, STEEL

*Godwin Co., W. S., Baltimore, Md.

CURB, STEEL PROTECTED

*Truscon Steel Co., Youngstown, O.
Concrete Steel Co., New York.
National Steel Fabric Co., Pittsburgh, Pa.
Steel Protected Concrete Co., Philadelphia, Pa.

CUTTERS, PIPE, HAND

Armstrong Mfg. Co., Bridgeport, Conn.
Erie Tool Works, Erie, Pa.
Greenfield Tap & Die Corp'n., Greenfield, Mass.
Oswego Tool Co., Oswego, N. Y.
Reed Mfg. Co., Erie, Pa.
Walworth Mfg. Co., Boston, Mass.

CUTTERS, ROD AND WIRE

*Koehring Co., Milwaukee, Wis.
Buffalo Forge Co., Buffalo, N. Y.
Carolus Mfg. Co., Sterling, Ill.
Carpenter & Co., Geo. B., Chicago, Ill.
Helwig Mfg. Co., St. Paul, Minn.
Worthington Pump & Mchy. Corp., New York.

CUTTING AND WELDING APPARATUS

Macleod Co., Cincinnati, O.
Milburn Co., Alexander, Baltimore, Md.

DERRICKS, GUY AND STIFF-LEG

*Insley Mfg. Co., Indianapolis, Ind.
American Hoist & Derrick Co., St. Paul, Minn.
Carpenter & Co., Geo. B., Chicago, Ill.
Clyde Iron Works Sales Co., Duluth, Minn.
Dobbie Fdry. & Mach. Co., Niagara Falls, N. Y.
Federal Bridge & Struc. Co., Waukesha, Wis.
Flory Mfg. Co., S., Bangor, Pa.
Horton Co., John T., New York.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
Lidgerwood Manufacturing Co., New York.
Lincoln Iron Works, Rutland, Vt.
National Hoisting Engine Co., Harrison, N. J.

Sasgen Derrick Co., Chicago, Ill.
Smith, Whitcomb & Cook Co., Barre, Vt.
Superior Iron Works, Superior, Wis.

DERRICKS, PIPE LAYING

*Austin Machinery Corp'n, Toledo, O.
Dobbie Fdry. & Mach. Co., Niagara Falls, N. Y.
Lidgerwood Manufacturing Co., New York.
Mueller Mfg. Co., H., Decatur, Ill.

DERRICKS, REVOLVING

Clyde Iron Works Sales Co., Duluth, Minn.
Dobbie Fdry. & Mach. Co., Niagara Falls, N. Y.
Lidgerwood Manufacturing Co., New York.

DERRICKS, STEEL

*Austin Machinery Corp'n, Toledo, O.
*Insley Mfg. Co., Indianapolis, Ind.
*Pawling & Harnischfeger Co., Milwaukee, Wis.
American Hoist & Derrick Co., St. Paul, Minn.
Buffalo Hoist & Derrick Co., Buffalo, N. Y.
Clyde Iron Works Sales Co., Duluth, Minn.
Dobbie Fdry. & Mach. Co., Niagara Falls, N. Y.
Hayward Co., New York.
Lakeside Bridge & Steel Co., N. Milwaukee, Wis.
Lidgerwood Manufacturing Co., New York.
Taylor Portable Steel Derrick Co., Chicago, Ill.

DERRICKS, STEEL PORTABLE

American Hoist & Derrick Co., St. Paul, Minn.
Clyde Iron Works Sales Co., Duluth, Minn.
Dobbie Fdry. & Mach. Co., Niagara Falls, N. Y.
Lidgerwood Manufacturing Co., New York.
Taylor Portable Steel Derrick Co., Chicago, Ill

DERRICKS, TRAVELING

*Austin Machinery Corp'n, Toledo, O.
American Hoist & Derrick Co., St. Paul, Minn.
Bay City Dredge Works, Bay City, Mich.
Clyde Iron Works Sales Co., Duluth, Minn.
Dobbie Fdry. & Mach. Co., Niagara Falls, N. Y.
Hayward Co., New York.
Nat'l Hoisting Engine Co., Harrison, N. J.
Orton & Steinbrenner Co., Chicago, Ill.

DIESEL ENGINES. (See Engines, Oil)

DISTRIBUTORS, TAR AND ASPHALT

*Kinney Mfg. Co., Boston, Mass.

DISTRIBUTING PLANTS, CONCRETE

*Insley Mfg. Co., Indianapolis, Ind.
*Koehring Co., Milwaukee, Wis.
*Ransome Concrete Mchy. Co., Dunellen, N. J.
Archer Iron Works, Chicago, Ill.
Lakewood Engineering Co., Cleveland, O.

DITCHING MACHINES (See Excavators, Ditch and Trench)

DIVIDING PLATES (ROAD)

*Godwin Co., W. S., Baltimore, Md.

DOORS, HOLLOW METAL

Dahlstrom Metallic Door Corp., Jamestown, N. Y.
United Metal Products Co., Canton, Ohio

DOORS, METAL (KALAMEIN)

Friedrich Co., E. H., Holyoke, Mass.
Lawton-Stephens Co., Brooklyn, N. Y.
McFarland Co., J. C., La Porte, Ind.
Penn Metal Co., Boston, Mass.
Riester & Thesmacher Co., Cleveland, Ohio.
Sykes Co., Chicago, Ill.
Thorp Fireproof Door Co., Minneapolis, Minn.

DOORS AND SHUTTERS, STEEL ROLLING

Cornell Iron Works, Inc., New York.
Kinnear Mfg. Co., Columbus, O.
Variety Fire Door Co., Chicago, Ill.
Wilson Corp., J. G., New York.

DRAFTING MACHINES

Universal Drafting Machine Co., Cleveland, O.

DREDGES

*Osgood Co., The, Marion, O.
*Street Bros. Mach. Wks., Chattanooga, Tenn.
American Steel Dredge Co., Fort Wayne, Ind.
Bay City Dredge Works, Bay City, Mich.
Bucyrus Co., South Milwaukee, Wis.
Ellicott Machine Corp'n., Baltimore, Md.
Erie Steam Shovel Co., Erie, Pa.
Hayward Co., New York.
Lidgerwood Mfg. Co., New York.
Marion Steam Shovel Co., Marion, O.
Michigan Dredge Co., Bay City, Mich.
Stockton Iron Works, Stockton, Cal.
Superior Iron Works, Superior, Wis.
Vulcan Iron Works, Jersey City, N. J.

DREDGES, DIPPER

*Austin Machinery Corp'n, Toledo, O.
*Osgood Co., Marion, O.
American Steel Dredge Co., Fort Wayne, Ind.
Bay City Dredge Works, Bay City, Mich.
Bucyrus Co., South Milwaukee, Wis.
Fairbanks Steam Shovel Co., Marion, O.
Marion Steam Shovel Co., Marion, O.

DREDGES, HYDRAULIC

Bucyrus Co., South Milwaukee, Wis.
Ellicott Mach. Corp., Baltimore, Md.
Fairbanks Steam Shovel Co., Marion, O.
Marion Steam Shovel Co., Marion, O.
Morris Machine Works, Baldwinsville, N. Y.

DREDGING PUMPS AND ACCESSORIES

Erie Pump & Engine Wks., Medina, N. Y.

DRILLS, AIR AND ROCK

*Dallett Co., The., Philadelphia, Pa.
*Denver Rock Drill Mfg. Co., Denver, Colo.
*McKiernan-Terry Drill Co., New York.
Chicago Pneumatic Tool Co., New York.
Cleveland Pneumatic Tool Co., Cleveland, O.
Cleveland Rock Drill Co., Cleveland, Ohio.
Helwig Mfg. Co., St. Paul, Minn.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Sullivan Machinery Co., Chicago, Ill.

DRILLS, CORE

*McKiernan-Terry Drill Co., New York.
Dobbins Core Drill Co., Inc., New York.
Ingersoll-Rand Co., New York.
Standard Diamond Drill Co., Chicago, Ill.
Sullivan Mach'y Co., Chicago, Ill.

DRILLS, HAMMER (PNEUMATIC)

*Denver Rock Drill Mfg. Co., Denver, Colo.
*McKiernan-Terry Drill Co., New York.
Chicago Pneumatic Tool Co., New York.
Cleveland Pneumatic Tool Co., Cleveland, O.
Cleveland Rock Drill Co., Cleveland, O.
Ingersoll-Rand Co., New York.
Sullivan Machinery Co., Chicago, Ill.

DRILLS FOR WELLS AND BLAST HOLES (See Well Drilling Machinery)

DRUMS, HOLDING

*Blaw-Knox Co., Pittsburgh, Pa.
Clyde Iron Works Sales Co., Duluth, Minn.
Dobbie Fdry. & Mach. Co., Niagara Falls, N. Y.
Hayward Co., New York.
Monighan Machine Co., Chicago, Ill.

DRYERS, ASPHALT AND CEMENT

*East Iron & Machine Co., Lima, Ohio.
Allis-Chalmers Co., Milwaukee, Wis.
American Blower Co., Detroit, Mich.
American Process Co., New York.
Atlas Dryer Co., Cleveland, O.
Bartlett & Snow Co., C. O., Cleveland, O.
Cummer & Son Co., F. D., Cleveland, O.
Ruggles-Coles Eng. Co., New York.
Variety Iron & Steel Works, Cleveland, O.

DRYERS, SAND AND GRAVEL

*Littleford Bros., Cincinnati, Ohio.

DUMP BODIES FOR MOTOR TRUCKS

*Heil Company, Milwaukee, Wis.
*Insley Mfg. Co., Indianapolis, Ind.
*International Motor Co., New York.
*Littleford Bros., Cincinnati, O.
*Wood Hydr. Hoist & Body Co., Detroit, Mich.
(Horizontal Hydraulic Hoist Co., Detroit, Mich.)
Archer Iron Works, Chicago, Ill.

Columbian Steel Tank Co., Kansas City, Mo.
Columbia Wagon & Body Co., Columbia, Pa.
Griscom-Russell Co., New York
Jennings Automatic Dump Body, Roanoke, Va.
Lee Trailer & Body Co., Chicago, Ill
Pechstein Iron Works, Keokuk, Iowa.
Van Dorn Iron Wks., Cleveland, Ohio.

DUMP CARTS AND WAGONS, HORSE DRAWN

*Austin Western Road Mchy. Co., Chicago, Ill.
*Russell Grader Mfg. Co., Minneapolis, Minn.
Acme Road Machinery Co., Frankfort, N. Y.
Acme Wagon Co., Emigsville, Pa.
Austin Mfg. Co., Chicago, Ill.
Columbia Wagon & Body Co., Columbia, Pa.
Convertible Wagon-Trailers, Inc., Buffalo, N. Y.
Eagle Wagon Works, Auburn, N. Y.
Holzbog & Bro., Geo. H., Jeffersonville, Ind.
Little Red Wagon Co., Omaha, Neb.
Tiffin Wagon Co., Tiffin, Ohio.
Watson Products Corp., Canastota, N. Y.
Western Wheeled Scraper Co., Aurora, Ill.

DUST LAYING (CALCIUM CHLORIDE)

*Dow Chemical Co., Midland, Mich.
*Solvay Process Co., Syracuse, N. Y.
Carbondale Calcium Co., Carbondale, Pa.

DYNAMITE (See Explosives)

EJECTORS, SEWAGE

Pacific Flush Tank Co., Chicago, Ill.
Yeomans Bros. Co., Chicago, Ill.

ELECTRIC GENERATORS AND MOTORS

Louis Allis Co., Milwaukee, Wis.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Crocker-Wheeler Co., Ampere, N. J.
Fairbanks, Morse & Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Ideal Elec. & Mfg. Co., Mansfield, O.
Lincoln Electric Co., Cleveland, O.
Robbins & Myers Co., Springfield, O.
Triumph Electric Co., Cincinnati, O.
Wagner Elec. Mfg. Co., St. Louis, Mo.
Western Electric Co., New York.
Westinghouse Elec. & Mfg. Co., E. Pittsb'gh, Pa.

ELECTRIC LAMPS

General Electric Co., Schenectady, N. Y.
Westinghouse Lamp Co., New York.

ELECTRIC LIGHTING PLANTS

*Climax Engineering Co., Clinton, Ia.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Fairbanks, Morse & Co., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Universal Motor Co., Oshkosh, Wis.
Westinghouse Elec. & Mfg. Co., E. Pittsb'gh, Pa.
Western Electric Co., New York.

ELECTRIC SUPPLIES, METERS, ETC.

Bissell Co., F., Toledo, Ohio.
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., E. Pittsb'gh, Pa.

ELECTRIC TRANSFORMERS

Allis-Chalmers Mfg. Co., Milwaukee, Wis.
General Electric Co., Schenectady, N. Y.
Kuhlman Electric Co., Bay City, Mich.
Westinghouse Elec. & Mfg. Co., E. Pittsb'gh, Pa.

ELECTRIC WIRES AND CABLES. (See "Wire and Cable")

ELEVATORS, BUCKET

*Atlas Eng. Co., Milwaukee, Wis.
*Austin Western Road Machy. Co., Chicago, Ill.
*Good Roads Mach'y Co., Kennett Square, Pa.
*Haiss Mfg. Co., Geo., New York.
*Littleford Bros., Cincinnati, Ohio.
*Russell Grader Mfg. Co., Minneapolis, Minn.
*Universal Road Machinery Co., Kingston, N. Y.
Austin Mfg. Co., Chicago, Ill.
Bartlett & Snow Co., C. O., Cleveland, Ohio.
Chain Belt Co., Milwaukee, Wis.
Fairfield Engineering Co., Lancaster, Ohio.
Gifford-Wood Co., Hudson, N. Y.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Chicago, Ill.
Olson & Co., Sam'l, Chicago, Ill.
Robins Conv. Belt Co., New York.
Webster Mfg. Co., Chicago, Ill.
Weller Mfg. Co., Chicago, Ill.
Worthington Pump & Mchy. Corp., New York.

ELEVATORS, PASSENGER, FREIGHT, ETC.

Amer. Elevator & Mach. Co., Louisville, Ky.
Atlantic Elevator Co., Inc., Philadelphia, Pa.
Bay State Elevator Co., Springfield, Mass.
Haughton Elev. & Mach. Co., Toledo, Ohio.
Kaestner & Hecht Co., Chicago, Ill.
Llewellyn Iron Works, Los Angeles, Cal.
Montgomery Elevator Co., Moline, Ill.
Otis Elevator Co., New York.
Ridgeway & Son Co., C., Coatesville, Pa.
See Elec. Elevator Co., A. B., New York.
Speidel, J. G., Reading, Pa.
Warner Elevator Mfg. Co., Cincinnati, O.
Warsaw Elevator Co., Warsaw, N. Y.

ENGINES, GAS AND GASOLINE

*Climax Engineering Co., Clinton, Ia.
*Hercules Corpn., Evansville, Ind.
*Holt Mfg. Co., Peoria, Ill.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Buda Co., Harvey, Ill.
C. H. & E. Mfg. Co., Milwaukee, Wis.
Charter Gas Eng. Co., Sterling, Ill.
Chicago Pneumatic Tool Co., New York.
Domestic Engine & Pump Co., Shippensburg, Pa.
Evinrude Motor Co., Milwaukee, Wis.
Fairbanks, Morse & Co., Chicago, Ill.
Foos Gas Engine Co., Springfield, Ohio.
Fuller & Johnson Mfg. Co., Madison, Wis.
Gade Bros. Mfg. Co., Iowa Falls, Iowa.
Le Roi Co., Milwaukee, Wis.
Nelson Bros. Co., Saginaw, Mich.
"New-Way" Motor Co., Lansing, Mich.
Novo Engine Co., Lansing, Mich.
Universal Motor Co., Oshkosh, Wis.
Weber Engine Co., Kansas City, Mo.
Wellman-Seaver-Morgan Co., Cleveland, O.
Worthington Pump & Mchy. Corp., New York

ENGINES, OIL

DIESEL

Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Busch-Sulzer Bros.-Diesel Eng. Co., St. Louis, Mo.
Dodge Sales & Eng. Co., Mishawaka, Ind.
Fulton Iron Works Co., St. Louis, Mo.
Hadfield-Penfield Steel Co., Bucyrus, Ohio.
McIntosh & Seymour Corp., Auburn, N. Y.
Nordberg Mfg. Co., Milwaukee, Wis.
Western Machy. Co., Los Angeles, Cal.

SEMI-DIESEL

Anderson Fdry. & Mach. Co., Anderson, Ind
Bessemer Gas Eng. Co., Grove City, Pa.
Buckeye Machinery Co., Lima, O.
Charter Gas Eng. Co., Sterling, Ill.
Chicago Pneumatic Tool Co., New York
De La Vergne Machine Co., New York
Evinrude Motor Co., Milwaukee, Wis.
Fairbanks, Morse & Co., Chicago, Ill.
Foos Gas Engine Co., Springfield, O.
Ingersoll-Rand Co., New York.
Midwest Engine Co., Indianapolis, Ind.
Muncie Oil Eng. Co., Muncie, Ind.
Nordberg Mfg. Co., Milwaukee, Wis.
St. Mary's Oil Eng. Co., St. Charles, Mo.
Stover Mfg. & Engine Co., Freeport, Ill.
Taylor Machine Co., Cleveland, O.
Weber Engine Co., Kansas City, Mo.
Worthington Pump & Mchy. Corp., New York.

ENGINES, PUMPING

*Climax Engineering Co., Clinton, Ia.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Hooven, Owen, Rentschler Co., Hamilton, O.
Murray Iron Wks., Burlington, Ia.
Nordberg Mfg. Co., Milwaukee, Wis.
Worthington Pump & Mchy. Corp., New York.

ENGINES, STEAM

Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Dake Engine Co., Grand Haven, Mich.
Erie-Ball Engine Co., Pittsburgh, Pa.
Erie Pump & Engine Co., Medina, N. Y.

Filer-Stowell Co., Milwaukee, Wis.
Hardie-Tynes Mfg. Co., Birmingham, Ala.
Leffel Co., J., Springfield, O.
Morris Machine Works, Baldwinsville, N. Y.
Murray Iron Works Co., Burlington, Ia.
Nordberg Mfg. Co., Milwaukee, Wis.
Sturtevant Co., B. F., Hyde Park, Boston, Mass.
Vilter Mfg. Co., Milwaukee, Wis.

EXCAVATING MACHINERY. (See Names Under Excavators, also Steam Shovels)

EXCAVATORS, CABLEWAY

Bucyrus Co., South Milwaukee, Wis.
Lidgerwood Mfg. Co., New York.

EXCAVATORS, DITCH AND TRENCH

*Austin Machinery Corp'n, Toledo, O.
*Insley Mfg. Co., Indianapolis, Ind.
*Keystone Driller Co., Beaver Falls, Pa.
*Osgood Co., The, Marion, O.
*Pawling & Harnischfeger Co., Milwaukee, Wis.
*Russell Grader Mfg. Co., Minneapolis, Minn.
American Hoist & Derrick Co., St. Paul, Minn.
Bay City Dredge Works, Bay City, Mich.
Byers Machine Co., Ravenna, Ohio.
Buckeye Traction Ditcher Co., Findlay, Ohio.
Bucyrus Co., South Milwaukee, Wis.
Clyde Iron Works Sales Co., Duluth, Minn.
Economy Excavator Co., Iowa Falls, Ia.
Erie Steam Shovel Co., Erie, Pa.
Fairbanks Steam Shovel Co., Marion, O.
Hayward Co., The, New York City.
Marion Steam Shovel Co., Marion, O.
Monighan Machine Co., Chicago, Ill.
Parsons Co., Newton, Ia.
Topping Machy. Co., Chas. T., Dayton, O.

EXCAVATORS, DRAG-LINE

*Austin Machinery Corp'n, Toledo, O.
*Bay City Dredge Works, Bay City, Mich.
*Osgood Co., The, Marion, O.
*Pawling & Harnischfeger Co., Milwaukee, Wis.
*Sauerman Bros., Chicago, Ill.
Browning Co., Cleveland, O.
Bucyrus Co., South Milwaukee, Wis.
Byers Machine Co., Ravenna, Ohio.
Clyde Iron Works Sales Co., Duluth, Minn.
Economy Excavator Co., Iowa Falls, Ia.
Erie Steam Shovel Co., Erie, Pa.
Gade Excavator Works, C. L., Iowa Falls, Iowa
Hayward Co., New York.
Industrial Works, Bay City, Mich.
Link-Belt Co., Chicago, Ill.
Marion Steam Shovel Co., Marion, O.
Monighan Machine Co., Chicago, Ill.
Parsons Co., Newton, Ia.
Smith Co., T. L., Milwaukee, Wis.

EXPANDED METAL

*Truscon Steel Co., Youngstown, O.
Berger Mfg. Co., Canton, O.
Consolidated Expanded Metal Co., Braddock, Pa.
Corrugated Bar Co., Inc., Buffalo, N. Y.
Northwestern Expanded Metal Co., Chicago, Ill.
Youngstown Pressed Steel, Co., Warren, O.

EXPANSION JOINT MATERIAL

*Barber Asphalt Co., Philadelphia, Pa.
*Carey Co., Philip, Cincinnati, Ohio.
*Texas Company, New York.
*Truscon Steel Co., Youngstown, O.
*Waring-Underwood Co., Philadelphia, Pa.
Asphalt Products Co., Coatesville, Pa.
Barrett Co., New York.
Pioneer Asphalt Co., Lawrenceville, Ill.

EXPLOSIVES

Atlas Powder Co., Wilmington, Del.
Du Pont de Nemours & Co., E.I., Wilmington, Del.
Giant Powder Co., Cons., San Francisco, Cal.
Hercules Powder Co., Wilmington, Del.

FENCING

*Wickwire Spencer Steel Corp., New York.
Adrian Wire Fence Co., Adrian, Mich.
American Steel & Wire Co., Chicago, Ill.
Anchor Post Iron Works, New York.
Cyclone Fence Co., Waukegan, Ill.
Frost-Superior Fence Co., Cleveland, O.
Indiana Steel & Wire Co., Muncie, Ind.
Nitselman Bros., Muncie, Ind.
Michigan Wire Fence Co., Adrian, Mich.
Page Steel & Wire Co., Bridgeport, Conn.
Pittsburgh Steel Co., Pittsburgh, Pa.
Stewart Iron Works Co., Cincinnati, Ohio.
Texas Cyclone Fence Co., Fort Worth, Tex.
Youngstown Sheet & Tube Co., Youngstown, O.

FILING EQUIPMENT, STEEL

Art Metal Constr. Co., Jamestown, N. Y.
Berger Mfg. Co., Canton, O.
General Fireproofing Co., Youngstown, O.
Van Dorn Iron Works, Cleveland, O.

FILTERS, OIL

Bowser & Co., Inc., S. F., Fort Wayne, Ind.
Wayne Tank & Pump Co., Ft. Wayne, Ind.

FILTERS, WATER

American Water Softener Co., Philadelphia, Pa.
Graver Corporation, E. Chicago, Ind.
International Filter Co., Chicago, Ill.
N. Y. Continental Jewel Filtr. Co., Nutley, N. J.
Norwood Engineering Co., Florence, Mass.
Roberts Filter Co., Darby, Pa.
Scaife & Sons Co., W. B., Pittsburgh, Pa.

FIRE ALARM SYSTEMS

Gamewell Fire Alarm Tel. Co., Newton Upper Falls, Mass.

FIRE ALARM SIRENS

Erick Elec. Siren Co., St. Paul, Minn.
Federal Sign System, Chicago, Ill.
Hondrie & Bolthoff Mfg. & Sup. Co., Denver, Col.
Interstate Machine Prod. Co., Rochester, N. Y.
Sireno Co., Stapleton, N. Y.
Union Water Meter Co., Worcester, Mass.

FIRE APPARATUS, MOTOR

*International Motor Co., New York.
Ahrens-Fox Fire Engine Co., Cincinnati, O.
American-La France Fire Eng. Co., Elmira, N. Y
Brockway Motor Fire App. Co., Cortlandt, N. Y.
Foamite-Childs Corp., Utica, N. Y.
Northern Fire Apparatus Co., Minneapolis, Minn.
Obenchain-Boyer Co., Logansport, Ind.
Pirsch & Sons Co., Peter, Kenosha, Wis.
Prospect Fire Engine Co., Prospect, O.
Seagrave Co., Columbus, O.
Stutz Fire Engine Co., Indianapolis, Ind.
Waterous Fire Engine Co., St. Paul, Minn.

FIRE EXTINGUISHERS, CHEMICAL

American-La France Fire Eng. Co., Elmira, N. Y.
Buffalo Fire Appliance Corp., Buffalo, N. Y.
Cross Mfg. Co., C. J., Inc., New York.
Foamite-Childs Co., Utica N. Y.
Pyrene Mfg. Co., Newark, N. J.

FIRE HOSE. (See Hose, Fire)

FIREPROOF BUILDING MATERIAL

*Truscon Steel Co., Youngstown, O.
Berger Mfg. Co., Canton, O.
Delaware Clay Products Co., Pittsburgh, Pa.
Detroit Steel Prod. Co., Detroit, Mich.
General Fireproofing Co., Youngstown, O.
Kalman Steel Co., Chicago, Ill.
Keasbey & Mattison Co., Ambler, Pa.
Kinnear Mfg. Co., Columbus, O.
National Fireproofing Co., Pittsburgh, Pa.
United States Gypsum Co., Chicago, Ill.
Youngstown Pressed Steel, Co., Warren, O.

FIRST AID EQUIPMENT

American-La France Fire Eng. Co., Elmira, N. Y.

FLEXIBLE JOINTS

*Central Foundry Co., New York.
*U. S. C. I. Pipe & Fdry Co., Burlington, N. J.
Coldwell-Wilcox Co., Newburgh, N. Y.
Crane Co., Chicago, Ill.
Lunkenheimer Co., Cincinnati, O.
United Lead Company, New York.

FLOORING, COMPOSITION

*Barber Asphalt Co., Philadelphia, Pa.
Am. Mason Safety Tread Co., Lowell, Mass.

Barrett Co., New York.
Johns-Manville Co., H. W., New York.
Marine Decking & Supply Co., Phila., Pa.
Muller, Franklyn R., & Co., Waukegan, Ill.

FLOORS, WOOD BLOCK
*Barrett Co., New York.
Carter Bloxonend Flooring Co., Kansas City, Mo.
Jennison-Wright Co., Toledo, O.
Midland Creosoting Co., Toledo, O.
Republic Creosoting Co., Indianapolis, Ind.
Servicised Products Co., Chicago, Ill.
Sou. Wood Preserving Co., Atlanta, Ga.
Wyckoff Pipe & Creosoting Co., New York.

FLUSH TANKS
Pacific Flush Tank Co., Chicago, Ill.

FLUSHERS, STREET. **(See Street Flushers and Sprinklers.)**

FORGES
Buffalo Forge Co., Buffalo, N. Y.
Hauck Mfg. Co., Brooklyn, N. Y.

FORM CLAMPS
*Insley Mfg. Co., Indianapolis, Ind.
Marion Malleable Iron Works, Marion, Ind.
Universal Form Clamp Co., Chicago, Ill.

FORMS, CONCRETE
*Blaw-Knox Co., Pittsburgh, Pa.
*Connery & Co., Philadelphia, Pa.
*Truscon Steel Co., Youngstown, O.
Concrete Form Co., Inc., Syracuse, N. Y.
Hetzel Steel Form & Iron Co., The, Warren, O.
Lakewood Eng. Co., Cleveland, Ohio.
Metal Forms Corp., Milwaukee, Wis.

FOUNTAINS, DRINKING
Casey-Hedges Co., Chattanooga, Tenn.
Clow & Sons, Jas. B., Chicago, Ill.
Crane Co., Chicago, Ill.
Mott Iron Wks., J. L., New York.
Murdock Mfg. & Supply Co., Cincinnati, Ohio.
Puro San. Dr. Ftn. Co., Haydenville, Mass.
Rundle-Spence Mfg. Co., Milwaukee, Wis.
Stewart Iron Works Co., Cincinnati, O.
Taylor Co., Halsey W., Warren, O.
Twentieth Century Brass Wks., Belleville, Ill.

FURNITURE AND FILES, STEEL
Art Metal Constn. Co., Jamestown, N. Y.
General Fireproofing Co., Youngstown, O.
Van Dorn Iron Works Co., Cleveland, O.

GARBAGE CANS. **(See Cans)**

GARBAGE DISPOSAL
American Beccari Corp., New York.
Balmer Corp., New York.
Bartlett, G. O. & Snow Co., Cleveland, O.
Decarie Incinerator Co., Minneapolis, Minn.
Jones & Very, New York
Morse-Boulger Destructor Co., New York.
Nye Odorless Crematory Co., Macon, Ga.

GARBAGE TRUCKS AND BODIES
*Heil Co., Milwaukee, Wis.
Convertible Wagon-Trailers, Inc., Buffalo, N. Y.
Holsbog & Bro., Geo. H., Jeffersonville, Ind.
Lee Trailer & Body Co., Chicago, Ill.
Tiffin Wagon Co., Tiffin, O.
Watson Products Corp., Canastota, N. Y.

GAS ENGINES. **(See Engines, Gas and Gasoline.)**

GAS METERS. **(See Meters, Gas)**

GAS PRODUCERS
Westinghouse Elec. & Mfg. Co., E. Pittsb'gh, Pa.
Wood & Co., R. D., Florence, N. J.

GASOLINE STORAGE TANKS
*Heil Co., Milwaukee, Wis.
*Littleford Bros., Cincinnati, O.
Bigge Boiler Works, Akron, Ohio.
Bowser & Co., Inc., S. F., Fort Wayne, Ind.
Byers Machine Co., Ravenna, Ohio.
Chicago Bridge & Iron Works, Chicago, Ill.
Scaife & Sons, Wm. B., Oakmont, Pa.
United Iron Works, Kansas City, Mo.
Wayne Tank & Pump Co., Ft. Wayne, Ind.

GATES, SLUICE
*Ludlow Valve Mfg. Co., Troy, N. Y.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Coffin Valve Co., Boston, Mass.
Coldwell-Wilcox Co., Newburgh, N. Y.
Hardesty Mfg. Co., The, Denver, Col.

GATES FOR PARKS AND CEMETERIES
*Wickwire Spencer Steel Corp., Worcester, Mass.
Stewart Iron Wks. Co., Cincinnati, O.

GAUGES, WATER
Bristol Co., Waterbury, Conn.
Lunkenheimer Co., Cincinnati, O.
United States Gauge Co., New York.
Walworth Mfg. Co., Boston, Mass.

GAUGES, SURFACE, RESERVOIR AND SPECIAL WATER-WORKS
*Clark Co., H. W., Mattoon, Ill.
Builders Iron Foundry, Providence, R. I.
Simplex Valve & Meter Co., Philadelphia, Pa.

GLASS, FIREPROOF. **(See Wire Glass.)**

GRADERS, ROAD **(See "Road Graders")**

GRADER BLADES
*Adams & Co., J. D., Indianapolis, Ind.
*Shunk Mfg. Co., Bucyrus, Ohio.

GRAND STANDS, PORTABLE
Leavitt Mfg. Co., Urbana, Ill.
Wayne Iron Wks., Philadelphia, Pa.

GRINDERS AND SAND RAMMERS
Chicago Pneumatic Tool Co., New York.
Cleveland Pneumatic Tool Co., Cleveland, Ohio.
Ingersoll-Rand Co., New York, N. Y.

GYPSUM PRODUCTS
U. S. Gypsum Co., Chicago, Ill.

HAMMER DRILLS
(See Drills, Hammer.)

HAMMERS, STEAM, PILE. **(See Pile Hammers, Steam)**

HEAT INSULATING MATERIAL
*Carey Co., Philip, Cincinnati, Ohio.
Johns-Manville, Inc., New York.

HEATERS AND DISTRIBUTORS, TAR AND ASPHALT HEATING KETTLES
*Kinney Mfg. Co., Boston, Mass.

HEATING KETTLES. **(See Kettles)**

HOISTS, BELT-DRIVEN
*Pawling & Harnischfeger Co., Milwaukee, Wis.
*Street Bros. Mach. Wks., Chattanooga, Tenn.
American Hoist & Derrick Co., St. Paul, Minn.
Dobbie Fdry. & Mach. Co., Niagara Falls, N. Y.
Lidgerwood Mfg. Co., New York.
Mead-Morrison Mfg. Co., E. Boston, Mass.
Mundy Hoisting Engine Co., J. S., Newark, N. J.
Weller Mfg. Co., Chicago, Ill.

HOISTS, CONCRETE, TOWER
*Insley Mfg. Co., Indianapolis, Ind.
*Ransome Concrete Mchy. Co., Dunellen, N. J.
Lakewood Engineering Co., Cleveland, O.
Mead-Morrison Mfg. Co., E. Boston, Mass.

HOISTS, ELECTRIC
*Pawling & Harnischfeger Co., Milwaukee, Wis.
*Street Bros. Mach. Wks., Chattanooga, Tenn.
American Hoist & Derrick Co., St. Paul, Minn.

C. H. & E. Mfg. Co., Milwaukee, Wis.
Clyde Iron Works Sales Co., Duluth, Minn.
Dobbie Fdry. & Mach. Co., Niagara Falls, N. Y.
Flory Mfg. Co., S., Bangor, Pa.
Lidgerwood Mfg. Co., New York.
Mead-Morrison Mfg. Co., E. Boston, Mass.
Mundy Hoisting Eng. Co., J. S., Newark, N. J.
National Hoisting Engine Co., Harrison, N. J.
Treadwell Eng. Co., Easton, Pa.

HOISTS, GASOLINE

*American Cement Mchy. Co., Inc., Keokuk, Ia.
*Austin Machinery Corp'n, Toledo, O.
*Domestic Engine & Pump Co., Shippensburg, Pa.
*Pawling & Harnischfeger Co., Milwaukee, Wis.
*Street Bros. Mach. Wks., Chattanooga, Tenn.
C. H. & E. Mfg. Co., Milwaukee, Wis.
Buffalo Hoist & Derrick Co., Buffalo, N. Y.
Clyde Iron Works Sales Co., Duluth, Minn.
Construction Machy. Co., Waterloo, Iowa.
Flory Mfg. Co., S., Bangor, Pa.
Lansing Co., Lansing, Mich.
Lidgerwood Mfg. Co., New York.
Mead-Morrison Mfg. Co., E. Boston, Mass.
Monighan Machine Co., Chicago, Ill.
Mundy Hoisting Engine Co., J. S., Newark, N. J.
National Hoisting Engine Co., Harrison, N. J.
Novo Engine Co., Lansing, Mich.
O. K. Clutch & Mach. Co., Columbia, Pa.
Orr & Sembower, Reading, Pa.
Schramm, Inc., West Chester, Pa.

HOISTS, PNEUMATIC

*Denver Rock Drill Mfg. Co., Denver, Colo.
Chicago Pneumatic Tool Co., New York.
Detroit Hoist & Machine Co., Detroit, Mich.
Hanna Eng. Works, Chicago, Ill.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Mead-Morrison Mfg. Co., E. Boston, Mass.
Northern Engineering Works, Detroit, Mich.
Sullivan Mach'y Co., Chicago, Ill.
Worthington Pump & Mchy. Corp., New York.

HOISTS, STEAM

*Austin Machinery Corp'n, Toledo, O.
*Denver Rock Drill Mfg. Co., Denver, Colo.
*Insley Mfg. Co., Indianapolis, Ind.
American Hoist & Derrick Co., St. Paul, Minn.
Byers Machine Co., Ravenna, Ohio.
Clyde Iron Works Sales Co., Duluth, Minn.
Flory Mfg. Co., S., Bangor, Pa.
Hardie-Tynes Mfg. Co., Birmingham, Ala.
Ingersoll-Rand Co., New York.
Lidgerwood Mfg. Co., New York.
Mead-Morrison Mfg. Co., E. Boston, Mass.
Mundy Hoisting Eng. Co., J. S., Newark, N. J.
National Hoisting Engine Co., Harrison, N. J.
Orr & Sembower, Reading, Pa.
Treadwell Eng. Co., Easton, Pa.

HOISTS FOR MOTOR TRUCKS

*Heil Co., The Milwaukee, Wis.
*Wood Hydr. Hoist & Body Co., Detroit, Mich.
(Horizontal Hydr. Hoist Co., Detroit, Mich.)
Rock Mfg. Co., Waterloo, N. Y.
Van Dorn Iron Wks., Cleveland, O.

HOLLOW TILE

Bannen Pipe Co., P., Louisville, Ky.
Dee Co., Wm. E., Chicago, Ill.
Delaware Clay Products Co., Pittsburgh, Pa.
Dickey Clay Mfg. Co., W. S., Kansas City, Mo.
Medal Paving Brick Co., Cleveland, Ohio.
Metropolitan Paving Brick Co., Canton, Ohio.
National Fireproofing Co., Pittsburgh, Pa.

HOPPERS, CONCRETE

*Insley Mfg. Co., Indianapolis, Ind.
*Littleford Bros., Cincinnati, O.
*Ransome Concrete Mchy. Co., Dunellen, N. J.
Lakewood Engineering Co., Cleveland, O.
Weller Mfg. Co., Chicago, Ill.

HOSE, AIR

Chicago Pneumatic Tool Co., New York
Cincinnati Rubber Mfg. Co., Cincinnati, O.
Goodyear Tire & Rubber Co., Akron, O.
Ingersoll-Rand Co., New York.
Penna Flexible Metallic Tubing Co., Phila., Pa.
Republic Rubber Co., Youngstown, O.
U. S. Rubber Co., New York

HOSE, FIRE

*Goodrich Rubber Co., B. F., Akron, O.
Bi-Lateral Fire Hose Co., Chicago, Ill.
Fabric Fire Hose Co., New York.
Goodyear Tire & Rubber Co., Akron, Ohio.
U. S. Rubber Co., New York.

HOUSE NUMBERS

Hamilton Metal Prod. Co., Hamilton, O.

HOUSES, PORTABLE. **(See Buildings, Portable)**

HYDRANTS, FIRE

*Ludlow Valve Mfg. Co., Troy, N. Y.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Columbian Iron Works, Chattanooga, Tenn.
Darling Valve & Mfg. Co., Williamsport, Pa.
Eddy Valve Mfg. Co., Waterford, N. Y.
Iowa Valve Co., Oskaloosa, Ia.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Norwood Engineering Co., Florence, Mass.
Rensselaer Valve Co., Troy, N. Y.
Smith Mfg. Co., A. P., East Orange, N. J.
Wood & Co., R. D., Philadelphia, Pa.

HYDRAULIC RAMS

Deming Co., Salem, O.
Rice Hydraulic Engine Co., New York
Seattle Machine Works, Seattle, Wash.

ICE-MAKING MACHINERY

Brunswick-Kroeschell Co., New Brunswick, N. J.
Carbondale Machine Co., Carbondale, Pa.
De La Vergne Machine Co., New York.
Frick Co., Inc., Waynesboro, Pa.
Triumph Ice Machine Co., Cincinnati, O.
United Iron Wks., Kansas City, Mo.
Vilter Mfg. Co., Milwaukee, Wis.
Vogt Mach. Co., Henry, Louisville, Ky.
York Mfg. Co., York, Pa.

INCINERATORS, GARBAGE. **(See Garbage Disposal)**

INDICATOR POSTS. **(See Valves)**

INSPECTING LABORATORIES

*Conard & Busby, Burlington, N. J.
*Standard Testing Laboratories, Inc., New York
Allentown Testing Laboratories, Allentown, Pa.
Conwell & Co., E. L., Philadelphia, Pa.
Gulick-Henderson Co., New York
Hunt & Co., Robert W., Chicago, Ill.
N. Y. Testing Laboratories, New York.
Pittsburgh Testing Laboratories, Pittsburgh, Pa.

INSTRUMENTS AND SUPPLIES. (Sudveyors' and Engineers')

Ainsworth & Sons, Wm., Denver, Col.
Beckman Co., L., Toledo, Ohio
Berger & Sons, C. L., Boston, Mass.
Brandis & Sons Mfg. Co., Brooklyn, N. Y.
Buff & Buff Mfg. Co., Boston, Mass.
Dietzgen Co., Eugene, Chicago, Ill.
Gurley, W. & L. E., Troy, N. Y.
Keuffel & Esser Co., Hoboken, N. J.
Kolesch & Co., New York.
Lietz Co., A., San Francisco, Cal.
Leupold & Voelpel, Portland, Ore.
Pfister, Wm. H., Cincinnati, O.
Ulmer, J. C., Co., Cleveland, Ohio.
Weber & Co., F., Philadelphia, Pa.
White Co., David, Milwaukee, Wis.
Wissler Instrument Co., St. Louis, Mo.

IRON WORK, STRUCTURAL AND ORNAMENTAL **(See Bridges and Buildings)**

JACKS, LIFTING

*McKiernan-Terry Drill Co., New York.
Buda Company, Chicago, Ill.
Duff Mfg. Co., Pittsburgh, Pa.
Joyce-Cridland Co., Dayton, O.
Norton, Inc., A. O., Boston, Mass.
Ree Mfg. Co., Pittsburgh, Pa.
Templeton, Kenly & Co., Ltd., Chicago, Ill.
Watson-Stillman Company, New York.

JACKS, PIPE FORCING
*Clark Co., H. W., Matteson, Ill.
Duff Mfg. Co., Pittsburgh, Pa.

JAIL AND PRISON WORK
Barnum Iron Works, E. T., Detroit, Mich.
Pauly Jail Bldg. Co., St. Louis, Mo.
Stewart Iron Works Co., Cincinnati, Ohio.
Van Dorn Iron Works Co., Cleveland, O.

JOINTS, EXPANSION PAVING
(See Expansion Joint Material)

JOINTS, FLEXIBLE PIPE. (See Flexible Joints.)

KETTLES, FOR ASPHALT AND TAR HEATING
*Barber Asphalt Co., Philadelphia, Pa.
*Connery & Co., Inc., Philadelphia, Pa.
*Good Roads Machinery Co., Kennett Square, Pa.
*Kinney Mfg. Co., Boston, Mass.
*Littleford Bros., Cincinnati, O.
*Universal Road Machinery Co., Kingston, N. Y.
Acme Road Mach. Co., Frankfort, N. Y.
Hauck Mfg. Co., Brooklyn, N. Y.
Honhorst Co., Jos., Cincinnati, Ohio.
Macleod Co., Cincinnati, O.
Stuebner Iron Wks., G. La., L. I. City, N. Y.
Tarrant Mfg. Co., Saratoga Springs, N. Y.
Union Iron Wks., Hoboken, N. J.

LANTERNS, CONTRACTORS'
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Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Steam Pump Co., Battle Creek, Mich.
Aurora Pump & Mfg. Co., Aurora, Ill.
Bethlehem Steel Co., Bethlehem, Pa.
Buffalo Steam Pump Co., Buffalo, N. Y.
Cameron Steam Pump Works, A. S., New York.
Dayton-Dowd Co., Quincy, Ill.
Dean Bros. Steam Pump Wks., Indianapolis, Ind.
De Laval Steam Turbine Co., Trenton, N. J.
Deming Co., Salem, O.
Fairbanks, Morse & Co., Chicago, Ill.
Gardner Governor Co., Quincy, Ill.
Goulds Mfg. Co., Seneca Falls, N. Y.
Indiana Air Pump Co., Indianapolis, Ind.
LeCourtenay Co., Newark, N. J.
Midwest Engine Co., Indianapolis, Ind.
Morris Machine Works, Baldwinsville, N. Y.
Murray Iron Works Co., Burlington, Ia.
Northern Fire Apparatus Co., Minneapolis, Minn
Scranton Pump Co., Scranton, Pa.
Union Steam Pump Co., Battle Creek, Mich
Vogt Bros. Mfg. Co., Louisville, Ky.
Warren Steam Pump Co., Warren, Mass.
Weinman Pump Mfg. Co., Columbus, O.
Yeomans Bros. Co., Chicago, Ill.

PUMPS, CENTRIFUGAL

*Domestic Engine & Pump Co., Shippensburg, Pa.
*Keystone Driller Co., Beaver Falls, Pa.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Well Works, Aurora, Ill.
Aurora Pump & Mfg. Co., Aurora, Ill.
Bethlehem Steel Co., Bethlehem, Pa.
Cameron Steam Pump Works, A. S., New York.
Dayton-Dowd Co., Quincy, Ill.
De Laval Steam Turbine Co., Trenton, N. J.
Erie Pump & Engine Works, Medina, N. Y.
Evinrude Motor Co., Milwaukee, Wis.
Fairbanks, Morse & Co., Chicago, Ill.
Goulds Mfg. Co., Seneca Falls, N. Y.
Indiana Air Pump Co., Indianapolis, Ind.
LeCourtenay Co., Newark, N. J.
Manistee Iron Wks., Manistee, Mich.
Midwest Engine Co., Indianapolis, Ind.

Morris Machine Works, Baldwinsville, N. Y.
Schramm, Inc., West Chester, Pa.
Tokheim Oil Tank & Pump Co., Ft. Wayne, Ind.
United Iron Works, Kansas City, Mo.
Wheeler Condenser & Eng. Co., Carteret, N. J.
Worthington Pump & Mchy. Corp., New York.
Yeomans Bros. Co., Chicago, Ill.

PUMPS, CONTRACTORS'

*Domestic Engine & Pump Co., Shippensburg, Pa.
*Kinney Mfg. Co., Boston, Mass.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Well Works, Aurora, Ill.
Aurora Pump & Mfg. Co., Aurora, Ill.
Barnes Mfg. Co., Mansfield, O.
Buda Co., Harvey, Ill.
Cameron Steam Pump Works, A. S., New York.
Carter Co., Ralph B., New York.
C. H. & E. Mfg. Co., Milwaukee, Wis.
Construction Mach'y Co., Waterloo, Ia.
Dayton-Dowd Co., Quincy, Ill.
Deming Co., Salem, Ohio.
Emerson Pump & Valve Co., Alexandria, Va.
Erie Pump & Engine Works, Medina, N. Y.
Evinrude Motor Co., Milwaukee, Wis.
Fairbanks, Morse & Co., Chicago, Ill.
Goulds Mfg. Co., Seneca Falls, N. Y.
LeCourtenay Co., Newark, N. J.
McGowan Co., J. H., Cincinnati, O.
Midwest Engine Co., Indianapolis, Ind.
Morris Machine Works, Baldwinsville, N. Y.
Myers & Bro. Co., F. E., Ashland, O.
Northern Fire App. Co., Minneapolis, Minn.
Novo Engine Co., Lansing, Mich.
Pulsometer Steam Pump Co., New York.
Schramm, Inc., West Chester, Pa.
Smith Co., T. L., Milwaukee, Wis.
Standard Scale & Supply Co., Pittsburgh, Pa.
Van Neuhuys Machine Wks., Albany, N. Y.
Waldo Bros. & Bond Co., Boston, Mass.

PUMPS, DEEP WELL

*Aldrich Pump Co., Allentown, Pa.
*Clark Co., H. W., Mattoon, Ill.
*Domestic Engine & Pump Co., Shippensburg, Pa.
*Keystone Driller Co., Beaver Falls, Pa.
American Well Works, Aurora, Ill.
Cameron Steam Pump Works, A. S., New York.
Cook, Inc., A. D., Lawrenceburg, Ind.
Deming Co., Salem, O.
Fairbanks, Morse & Co., Chicago, Ill.
Goulds Mfg. Co., Seneca Falls, N. Y.
Harris Air Pump Co., Indianapolis, Ind.
Indiana Air Pump Co., Indianapolis, Ind.
Layne & Bowler Co., Memphis, Tenn.
McDonald Mfg. Co., A. Y., Dubuque, Ia.
Midwest Engine Co., Indianapolis, Ind.
Myers & Bro. Co., F. E., Ashland, O.
United Iron Works, Kansas City, Mo.
Weber Subterranean Pump Co., New York.

PUMPS, DREDGING

*Aldrich Pump Co., Allentown, Pa.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Well Works, Aurora, Ill.
Aurora Pump & Mfg. Co., Aurora, Ill.
Buffalo Steam Pump Co., Buffalo, N. Y.
Cameron Steam Pump Wks., A. S., New York.
Erie Pump & Engine Co., Medina, N. Y.
Morris Machine Works, Baldwinsville, N. Y.
Ramsey Pump Co., Ltd., Seneca Falls, N. Y.
Wood & Co., R. D., Philadelphia, Pa.
Worthington Pump & Mchy. Corp., New York.

PUMPS, GASOLINE AND OIL

*Kinney Mfg. Co., Boston, Mass.
Bowser & Co., Inc., S. F., Fort Wayne, Ind.
Gilbert & Barker Mfg. Co., Springfield, Mass.
Wayne Tank & Pump Co., Fort Wayne, Ind.

PUMPS, POWER

*Kinney Mfg. Co., Boston, Mass.
*Koehring Co., Milwaukee, Wis.
Alamo Iron Works, San Antonio, Tex.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
American Steam Pump Co., Battle Creek, Mich
American Well Works, Aurora, Ill.
Aurora Pump & Mfg. Co., Aurora, Ill.
Barnes Mfg. Co., Mansfield, O.
Dayton-Dowd Co., Quincy, Ill.
De Laval Steam Turbine Co., Trenton, N. J.
Deming Co., Salem, O.
Domestic Engine & Pump Co., Shippensburg, Pa.
Evinrude Motor Co., Milwaukee, Wis.
Fairbanks, Morse & Co., Chicago, Ill.
Gardner Governor Co., Quincy, Ill.
Goulds Mfg. Co., Seneca Falls, N. Y.
Indiana Air Pump Co., Indianapolis, Ind.
Lawrence Machine Co., Lawrence, Mass.
Le-Courtenay Co., Newark, N. J.
McGowan Co., J. H., Cincinnati, O.
Myers & Bro. Co., F. E., Ashland, O.
Nordberg Mfg. Co., Milwaukee, Wis.
Northern Fire Aparatus Co., Minneapolis, Minn.
Weinman Pump Mfg. Co., Columbus, O.
Worthington Pump & Machy. Corp., New York.
Yeomans Bros. Co., Chicago, Ill.

PUMPS, TAR AND ASPHALT

*Kinney Mfg. Co., Boston, Mass.

RAILS AND RAIL JOINTS

*Koppel Ind. Car & Equip. Co., Koppel, Pa.
Bethlehem Steel Co., Bethlehem, Pa.
Carnegie Steel Co., Pittsburgh, Pa.
Sweet's Steel Co., Williamsport, Pa.

RAILROAD DITCHERS (See Excavators, Ditch and Trench.)

RECORDERS, WATER STAGE

Builders Iron Fdry., Providence, R. I.
Gurley, W. & L. E., Troy, N. Y.

REFRIGERATING MACHINERY. (See Ice Making Machinery.)

REINFORCING CONCRETE. (See Concrete Reinforcements.)

RIVETERS, PNEUMATIC

Alliance Machine Co., Alliance, O.
Chicago Pneumatic Tool Co., New York.
Cleveland Pneumatic Tool Co., Cleveland, O.
Hanna Eng. Works, Chicago, Ill.
Helwig Mfg. Co., St. Paul, Minn.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.
Watson-Stillman Co., New York.

RIVET SETS

Cleveland Pneumatic Tool Co., Cleveland, O.
Dunbar Drop Forge Co., Chicago, Ill.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., New York.

RIVETS, BRIDGE AND STRUCTURAL. (See Bolts, Nuts, Etc.)

ROAD GRADERS

*Adams & Co., J. D., Indianapolis, Ind.
*Austin-Western Road Mchy. Co., Chicago, Ill.
*Baker Mfg. Co., Springfield, Ill.
*Galion Iron Works & Mfg. Co., Galion, Ohio.
*Good Roads Mach'y Co., Kennett Square, Pa.
*Monroe & Sons, N. S., Arthur, Ill.
*Russell Grader Mfg. Co., Minneapolis, Minn.
*Stockland Road Mach. Co., Minneapolis, Minn.
Case Threshing Machine Co., J. I., Racine, Wis.
Lyle Culv. & Rd. Equip. Co., Minneapolis, Minn.
Shaw-Enochs Tractor Co., Minneapolis, Minn.
Smith & Sons Mfg. Co., Kansas City, Mo.

ROAD OILS. (See Oils, Road.)

ROAD OILERS

*Austin-Western Road Mchy. Co., Chicago, Ill.
*Connery & Co., Philadelphia, Pa.
*Good Roads Mach. Co., Kennett Square, Pa.
*International Motor Co., New York.
*Kinney Mfg. Co., Boston, Mass.
*Littleford Bros., Cincinnati, Ohio.
Etnyre & Co., E. D., Oregon, Ill.
White Co., Cleveland, O.

ROAD SCRAPERS

*Adams & Co., J. D., Indianapolis, Ind.
*Austin-Western Road Mchy. Co., Chicago, Ill.
*Baker Mfg. Co., Springfield, Ill.
*East Iron & Machine Co., Lima, Ohio.
*Galion Iron Works & Mfg. Co., Galion, O.
*Good Roads Mach. Co., Kennett Square, Pa.
*Russell Grader Mfg. Co., Minneapolis, Minn.

Acme Road Mach. Co., Frankfort, N. Y.
Avery Co., Peoria, Ill.
Case Threshing Machine Co., J. I., Racine, Wis.
Lyle Culv. & Rd. Equip. Co., Minneapolis, Minn.
Root Spring Scraper Co., Kalamazoo, Mich.
Sidney Steel Scraper Co., Sidney, O.
Smith & Sons Mfg. Co., Kansas City, Mo.
Western Wheeled Scraper Co., Aurora, Ill.

ROAD AND PAVING ROLLERS

*Austin-Western Road Mchy. Co., Chicago, Ill.
*Barber Asphalt Co., Philadelphia, Pa.
*Buffalo Springfield Roller Co., Springfield, O.
*Erie Machine Shops, Erie, Pa.
*Galion Iron Works & Mfg. Co., Galion, Ohio.
*Good Roads Mach. Co., Kennett Square, Pa.
*Huber Mfg. Co., Marion, O.
Case Threshing Machine Co., J. I., Racine, Wis.

ROAD AND PAVING MACHINERY

*Adams & Co., J. D., Indianapolis, Ind.
*Atlas Engineering Co., Milwaukee, Wis.
*Austin Machinery Corp'n, Toledo, O.
*Austin-Western Road Mchy. Co., Chicago, Ill.
*Baker Mfg. Co., Springfield, Ill.
*Barber Asphalt Co., Philadelphia, Pa.
*Buffalo Springfield Roller Co, Springfield, O.
*Connery & Co., Inc., Philadelphia, Pa.
*East Iron & Mach Co, Lima, Ohio.
*Erie Machine Shops, Erie, Pa.
*Equitable Asph. Maint. Co., Kansas City, Mo.
*Galion Iron Works & Mfg. Co., Galion, Ohio.
*Good Roads Mach. Co., Kennett Square, Pa.
*Haiss Mfg. Co., Geo., New York.
*Holt Mfg. Co., Peoria, Ill.
*International Motor Co., New York
*Kinney Mfg. Co., Boston, Mass.
*Koehring Co., Milwaukee, Wis.
*Littleford Bros., Cincinnati, O.
*Monroe & Sons, N. S., Arthur, Ill.
*Ransome Concrete Mchy. Co., Dunellen, N. J.
*Russell Grader Mfg. Co., Minneapolis, Minn.
*Stockland Road Mach. Co., Minneapolis, Minn.
*Universal Road Mchy. Co., Kingston, N. Y.
Acme Road Mach. Co., Frankfort, N. Y.
Aultman & Taylor Mach. Co., Mansfield, Ohio.
Avery Co., Peoria, Ill.
Bucyrus Road Machy. Co., Bucyrus, O.
Case Threshing Mach. Co., J. I. Racine, Wis.
Cummer & Son Co., F. D., Cleveland, O.
Edwards Mfg. Co., C. D., Albert Lea, Minn.
Glide Road Mach'y Co., Minneapolis, Minn.
Honhorst Co., Jos., Cincinnati, O.
Lakewood Engineering Co., Cleveland, O.
Lyle Culv. & Rd. Equip. Co., Minneapolis, Minn.
Smith Co., T. L., Milwaukee, Wis.
Smith & Sons Mfg. Co., Kansas City, Mo.
United Iron Works, Kansas City, Mo.

ROCK CRUSHERS AND PULVERIZERS (See "Crushers")

ROCK DRILLS. (See Drills, Rock)

ROOFING, ASPHALT, COMPOSITION, TILE, ETC.

*Barber Asphalt Co., Philadelphia, Pa.
*Barrett Co., New York
*Carey Co., Philip, Cincinnati, Ohio.
*Standard Oil Co. (Indiana), Chicago, Ill.
*Texas Co., New York.
American Cement Tile Mfg. Co., Pittsburgh, Pa.
Atlantic Refining & Asphalt Corp., Phila., Pa.
Beaver Board Cos., Buffalo, N. Y.
Bird & Son, Inc., E. Walpole, Mass.
Certain-teed Products Corp., New York.
Chatfield Mfg. Co., Cincinnati, Ohio.
Edwards Mfg. Co., Cincinnati, O.
Flintkote Co., Boston, Mass.
Johns-Manville, Inc., New York.
Keystone Roofing Mfg. Co., York, Pa.
Lehon Co., The, Chicago, Ill.
Lewis Mfg. Co., F. J., Chicago, Ill.
National Roofing Co., Tonawanda, N. Y.
Ruberoid Co., New York.
Sall Mountain Co., Chicago, Ill.
Sifo Products Co., St. Paul, Minn.
Sonneborn & Sons, Inc., L., New York.
United States Gypsum Co., Chicago, Ill.
Western Elaterite Roofing Co., Denver, Colo.

ROOFING, METAL

*Truscon Steel Co., Youngstown, O.
American Rolling Mill Co., Middletown, Ohio.
Berger Mfg. Co., Canton, O.
Edwards Mfg. Co., Cincinnati, O.
Klauer Mfg. Co., Dubuque, Ia.
Milwaukee Corrugating Co., Milwaukee, Wis.
Nat'l Sheet Metal Roofing Co., Jersey City, N. J
United Alloy Steel Corpn., Canton, O.
Youngstown Sheet & Tube Co., Youngstown, O.

ROOFING KETTLES. (See Kettles)

ROPE, MANILA

American Mfg. Co., Brooklyn, New York.
Columbian Rope Co., Auburn, N. Y.
Cupples Cordage Co., Brooklyn, N. Y.
Hooven & Allison Co., Xenia, O.
Kelly Co., R. A., Xenia, O.
New Bedford Cordage Co., New Bedford, Mass
Peoria Cordage Co., Peoria, Ill.
Plymouth Cordage Co., N. Plymouth, Mass.
Wall Rope Wks., New York.
Waterbury Co., New York.
Whitlock Cordage Co., New York.

ROPE, WIRE, HOISTING, HAULAGE

*Wickwire Spencer Steel Corp., New York.
*Williamsport Wire Rope Co., Williamsport, Pa.
American Steel & Wire Co., Chicago, Ill.
Broderick & Bascom Rope Co., St. Louis, Mo.
Leschen & Sons Rope Co., A., St. Louis, Mo.
MacWhyte Co., Kenosha, Wis.
Moon Co., Geo. C., Garwood, N. J.
Roebling's Sons Co., J. A., Trenton, N. J.
Upson-Walton Co., Cleveland, O.
Waterbury Co., New York.

RUBBER TIRES. (See Tires.)

RULES

Lufkin Rule Co., Saginaw, Mich.

SAFETY TREADS. (See Treads, Safety)

SASH, ROLLED STEEL. (See Window Frames and Sash)

SAW RIGS, PORTABLE

Amer. Saw Mill Mach. Co., Hackettstown, N. J.
C. H. & E. Mfg. Co., Milwaukee, Wis.
Knickerbocker Co., Jackson, Mich.
Oshkosh Mfg. Co., Oshkosh, Wis.

SCARIFIERS

*Adams & Co., J. D., Indianapolis, Ind.
*Austin Western Road Mchy. Co., Chicago, Ill.
*Barber Asphalt Co., Philadelphia, Pa.
*Buffalo Springfield Roller Co., Springfield, O.
*Galion Iron Works & Mfg. Co., Galion, Ohio.
*Good Roads Mach. Co., Kennett Square, Pa.
*Huber Mfg. Co., Marion, O.
*Kinney Mfg. Co., Boston, Mass.
*Russell Grader Mfg. Co., Minneapolis, Minn.
*Stockland Road Mach. Co., Minneapolis, Minn.
*Universal Road Machinery Co., Kingston, N. Y.
Acme Road Mach. Co., Frankfort, N. Y.
Avery Co., Peoria, Ill.
Case Threshing Mach. Co., J. I., Racine, Wis.
Lyle Cul. & Rd. Equip. Co., Minneapolis, Minn.

SCARIFIERS, TEETH FOR

*Shunk Mfg. Co., Bucyrus, Ohio.

SCRAPERS, POWER DRAG

*Sauerman Bros., Chicago, Ill.

SCRAPERS, ROAD (See Road Scrapers)

SCRAPERS, SELF-LOADING

*Baker Mfg. Co., Springfield, Ill.
Smith & Sons Mfg. Co., Kansas City, Mo.

SCREENS, SAND, GRAVEL AND COAL

*Atlas Eng. Co., Milwaukee, Wis.
*Austin-Western Road Mchy. Co., Chicago, Ill.
*Good Roads Mach'y Co., Kennett Square, Pa.
*Haiss Mfg. Co., Geo., New York.
*Littleford Bros., Cincinnati, O.
*Russell Grader Mfg. Co., Minneapolis, Minn.

*Universal Road Machinery Co., Kingston, N. Y.
*Wickwire Spencer Steel Corp., New York.
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
Austin Mfg. Co., Chicago, Ill.
Bartlett & Snow Co., Cleveland, O.
Case Threshing Machine Co., J. I., Racine, Wis.
Chain Belt Co., Milwaukee, Wis.
Galion Iron Wks. & Mfg. Co., Galion, Ohio.
Gifford-Wood Co., Hudson, N. Y.
Hendrick Mfg. Co., Carbondale, Pa.
Jeffrey Mfg. Co., Columbus, O.
Link-Belt Co., Chicago, Ill.
Lyle Culv. & Rd. Equip. Co., Minneapolis, Minn.
Newaygo Eng. Co., Newaygo, Mich.
New Jersey Wire Cloth Co., Trenton, N. J.
Robins Conv. Belt Co., New York.
Sackett Screen & Chute Co., H. B., Chicago, Ill.
Webster Mfg. Co., Chicago, Ill.
Weller Mfg. Co., Chicago, Ill.

SCREENS, SEWAGE

Chain Belt Co., Milwaukee, Wis.
Link-Belt Co., Philadelphia, Pa.
Sanitation Corp'n, New York.

SEWAGE DISPOSAL APPARATUS

Direct Oxidation Disposal Corp., Phila., Pa.
Dorr Co., New York
Pacific Flush Tank Co., Chicago, Ill.
Sanitation Corp'n, New York.

SEWAGE PUMPS (See "Pumps, Centrifugal")

SEWAGE EJECTORS

Pacific Flush Tank Co., Chicago, Ill.
Sanitation Corp'n, New York.
Yeomans Bros. Co., Chicago, Ill.

SEWER BLOCKS, SEGMENT

American Vit. Products Co., Akron, O.
Cannelton Sewer Pipe Co., Cannelton, Ind.
Denver Sewer Pipe & Clay Co., Denver, Col.
Evens & Howard Fire Brick Co., St. Louis, Mo.
Dickey Clay Mfg. Co., W. S., Kansas City, Mo.
Laclede Christy Clay Products Co., St. Louis, Mo.
Macomb Sewer Pipe Wks., Macomb, Ill.
Pacific Clay Products Co., Los Angeles, Cal.
Red Wing Sewer Pipe Co., Red Wing, Minn.
Robinson Clay Product Co., Akron, O.
Standard Fire Brick & Sewer Pipe Co., Pueblo, Col.

SEWER CLEANING APPARATUS

Champion Corporation, Hammond, Ind.
Self Propelling Nozzle Co., New York.
Thompson Sewer Machine Co., Buffalo, N. Y.
Turbine Sewer Machine Co., Milwaukee, Wis.

SEWER PIPE AND DRAIN TILE

American Vit. Products Co., Akron, O.
Blackmer & Post Pipe Co., St. Louis, Mo.
Dee Co., Wm. E., Chicago, Ill.
Delaware Clay Products Co., Pittsburgh, Pa.
Denver Sewer Pipe & Clay Co., Denver, Col.
National Fireproofing Co., Pittsburgh, Pa.
Ohio Vitrified Pipe Co., Uhrichsville, O.
Robinson Clay Product Co., Akron, O.

SEWER RODS

Bissell Co., F., Toledo, O.
Champion Corporation, Hammond, Ind.
Turbine Sewer Machine Co., Milwaukee, Wis.

SHINGLES, METAL.

Berger Mfg. Co., Canton, Ohio.
Canton Art Metal Co., Canton, Ohio.
Edwards Mfg. Co., Cincinnati, Ohio.
Eller Mfg. Co., Canton, Ohio.
Milwaukee Corrugating Co., Milwaukee, Wis.
Nat'l Sheet Metal Roofing Co., Jersey City, N. J.
Newport Rolling Mill Co., Newport, Ky.
Penn Metal Co., Boston, Mass.
Klauer Mfg. Co., Dubuque, Ia.
Tiffin Art Metal Co., Tiffin, Ohio.
Wheeling Metal Mfg. Co., Wheeling, W. Va.

SHOVELS, ELECTRIC

Bucyrus Co., South Milwaukee, Wis.
Marion Steam Shovel Co., Marion, O.
Thew Shovel Co., Lorain, O.

SHOVELS, GASOLINE

*Pawling & Harnischfeger Co., Milwaukee, Wis.
American Steel Dredge Co., Fort Wayne, Ind.
Austin Machinery Corp'n, Toledo, O.
Bay City Dredge Works, Bay City, Mich.
Fairbanks Steam Shovel Co., Marion, O.
Marion Steam Shovel Co., Marion, O.
Thew Shovel Co., Lorain, O.

SHOVELS, HAND

Ames Shovel & Tool Co., Boston, Mass.
Beall Bros. Co., Alton, Ill.
Conneaut Shovel Co., Conneaut, O.
Hubbard & Co., Pittsburgh, Pa.
Indiana Shovel Co., New Castle, Ind.
Jackson Shovel Co., Montpelier, Ind.
Pittsburgh Shovel Co., Pittsburgh, Pa.
Russell Shovel Co., Ailquippa, Pa.
Stevens-Webb Co., Inc., Altoona, Pa.
Union Furnace Mfg. Co., Altoona, Pa.
Wood Shovel & Tool Co., Piqua, Ohio.
Wyoming Shovel Works, Wyoming, Pa.

SHOVELS, STEAM

*Austin Machinery Corp'n, Toledo, O.
*Keystone Driller Co., Beaver Falls, Pa.
*Osgood Co., The, Marion, O.
Bellwood Steam Shovel Co., Bellwood, Pa.
Browning Co., Cleveland, O.
Bucyrus Co., South Milwaukee, Wis.
Byers Machine Co., J. F., Ravenna, Ohio.
Erie Steam Shovel Co., Erie, Pa.
Fairbanks Steam Shovel Co., Marion, O.
Industrial Works, Bay City, Mich.
Marion Steam Shovel Co., Marion, O.
Smith Co., T. L., Milwaukee, Wis.
Thew Shovel Co., Lorain, O.

SIGNS, STREET AND ROAD

Baltimore Enamel & Novelty Co., Baltimore, Md.
Ingram-Richardson Mfg. Co., Beaver Falls, Pa.
Lyle-Signs, Minneapolis, Minn.
Municipal Products & Elec. Co., Buffalo, N. Y.
Municipal Street Sign Co., New York.
Nelke Sign Co., J. L., New York.
Safety Traffic Guide Co., Elkhart, Ind.
Union Iron Products Co., East Chicago, Ind.
Western Display & Mfg. Co., St. Paul, Minn.

SIGNS, TRAFFIC

Automatic Signal & Sign Co., Chicago, Ill.
Best Traffic Light Co., E. Peoria, Ill.
Elkhart Fdry. & Mach. Co., Elkhart, Ind.
Esseo Mfg. Co., Peoria, Ill.
Lebanon Machine Co., Lebanon, N. H.
Little Giant Co., Mankato, Minn.
Lyle-Signs, Minneapolis, Minn
Ohio Traffic Devices Co., Columbus, O.
Safety Traffic Guide Co., Elkhart, Ind.
Traffic Sign & Signal Co., Gloucester, Mass.
Union Iron Products Co., E. Chicago, Ind.

SLATE, ROOFING

Vendor Slate Co., Inc., Easton, Pa.

SLATE, STRUCTURAL

Keenan Structural Slate Co., Bangor, Pa.
Penna. Structural Slate Co., Easton, Pa.
Phœnix Slate Co., Windgap, Pa.
Structural Slate Co., Pen Argyl, Pa.

SLEEVES, TAPPING AND VALVE

Mueller Company, Decatur, Ill.
Rensselaer Valve Co., Troy, N. Y.
Smith Mfg. Co., A. P., East Orange, N. J.

SLUICE GATES. (See Gates, Sluice.)

SMOKE STACKS. (See Stacks, Steel)

SNOW CLEANING MACHINERY

*Austin-Western Road Mchy. Co., Chicago, Ill.
*Baker Mfg. Co., Springfield, Ill.
*Good Roads Mach. Co., Kennett Square, Pa.
*Holt Mfg. Co., Peoria, Ill.
*International Motor Co., New York.
Avery Co., Peoria, Ill.
Barber-Greene Co., Aurora, Ill.
Cleveland Tractor Co., Cleveland, Ohio.
Monarch Tractors, Inc., Watertown, Wis.
J. T. Tractor Co., Cleveland, O.

Toy Co., W. M., Sidney, Ohio.
Owensboro Ditcher & Grader Co., Owensboro, Ky.

SPRAYERS, ASPHALT AND TAR
*Kinney Mfg. Co., Boston, Mass.

SPRAYING MACHINERY FOR TREES
Bean Spray Pump Co., Lansing, Mich.
Deming Co., The, Salem, Ohio.
Field Force Pump Co., Elmira, N. Y.
Fitchburg-Guptill Co., East Cambridge, Mass.

SPREADERS, STONE
*Austin-Western Road Mchy. Co., Chicago, Ill.
*Burch Plow Works Co., Crestline, O.

STACKS, STEEL
*Blaw-Knox Co., Pittsburgh, Pa.
*Connery & Co., Inc., Philadelphia, Pa.
*Heil Co., The, Milwaukee, Wis.
*Littleford Bros., Cincinnati, O.
Chatta. Boiler & Tank Co., Chattanooga, Tenn.
Chicago Bridge & Iron Works, Chicago, Ill.
Honhorst Co., Jos., Cincinnati, O.
Petroleum Iron Works Co., Sharon, Pa.
Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa.
Scaife & Sons Co., Wm. B., Pittsburgh, Pa.
Walsh & Weidner Boiler Co., Chattanooga, Tenn.

STANDPIPES, TANKS AND TOWERS
*Connery & Co., Inc., Philadelphia, Pa.
Caldwell Co., W. E., Louisville, Ky.
Chattanooga Bir. & Tank Co., Chattanooga, Tenn.
Chicago Bridge & Iron Works, Chicago, Ill.
Lancaster Iron Wks., Lancaster, Pa.
Pacific Tank & Pipe Co., San Francisco, Cal.
Petroleum Iron Works Co., Sharon, Pa.
Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa.
United Iron Works, Kansas City, Mo.
Walsh & Weidner Boiler Co., Chattanooga, Tenn.

STEAM SHOVELS. **(See Shovels, Steam)**

STEAM TURBINES
Allis-Chalmers Mfg. Co., Milwaukee, Wis.
De Laval Steam Turbine Co., Trenton, N. J.
Ingersoll-Rand Co., New York.
Westinghouse Elec. & Mfg. Co., E. Pittsb'gh, Pa.

STEEL PLATE CONSTRUCTION
*Blaw-Knox Co., Pittsburgh, Pa.
*Connery & Co., Philadelphia, Pa.
*Heil Co., The, Milwaukee, Wis.
*Littleford Bros., Cincinnati, O.
Bethlehem Steel Co., Bethlehem, Pa.
Biggs Boiler Wks., Akron, O.
Chatta. Boiler & Tank Co., Chattanooga, Tenn.
Chicago Bridge & Iron Works, Chicago, Ill.
Graver Corporation, E. Chicago, Ind.
Heltzel Steel Form & Iron Co., Warren, O.
Hendrick Mfg. Co., Carbondale, Pa.
Honhorst Co., Jos., Cincinnati, Ohio.
McClintic-Marshall Co., Pittsburgh, Pa.
Pennsylvania Bridge Co., Beaver Falls, Pa.
Petroleum Iron Works Co., Sharon, Pa.
Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa.
Riter-Conley Co., Pittsburgh, Pa.
Scaife & Sons, Wm. B., Pittsburgh, Pa.
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Vulcan Iron Works, Jersey City, N. J.
Walsh & Weidner Boiler Co., Chattanooga, Tenn.

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Babcock & Wilcox Co., New York
Combustion Engine Corp., New York
Detroit Stoker Co., Detroit, Mich.
Laclede-Christy Clay Prod. Co., St. Louis, Mo.
Murphy Iron Works, Detroit, Mich.
Sanford Riley Stoker Co., Worcester, Mass.
Westinghouse Elec. & Mfg. Co., E. Pittsb'gh, Pa.

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Tarrant Mfg. Co., Saratoga Springs, N. Y.

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*Kinney Mfg. Co., Boston, Mass.
*International Motor Co., New York.
*Municipal Supply Co., South Bend, Ind.
Autocar Co., Ardmore, Pa.
Etnyre & Co., E. D., Oregon, Ill.
Federal Motor Truck Co., Detroit, Mich.
Pierce Arrow Motor Car Co., Buffalo, N. Y.
Tiffin Wagon Co., Tiffin, O.
White Co., Cleveland, O.

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General Electric Co., Schenectady, N. Y.
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Massey Concrete Products Co., Chicago, Ill.
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Union Metal Mfg. Co., Canton, O.
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*Good Roads Mach. Co., Kennett Square, Pa.
*Universal Road Machinery Co., Kingston, N. Y.
Elgin Sales Corp'n, New York.
Foamite-Childs Corp., Utica, N. Y.
Springfield Motor Sweeper Co., Springfield, O.

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Thomas Elevator Co., Chicago, Ill.

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Power Specialty Co., New York.
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*Connery & Co., Inc., Philadelphia, Pa.
*Heil Co., Milwaukee, Wis.
*Littleford Bros., Cincinnati, O.
Abendroth & Root Mfg. Co., New York.
Biggs Boiler Wks., Akron, O.
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Chicago Pneumatic Tool Co., New York
Graver Corporation, E. Chicago, Ind.
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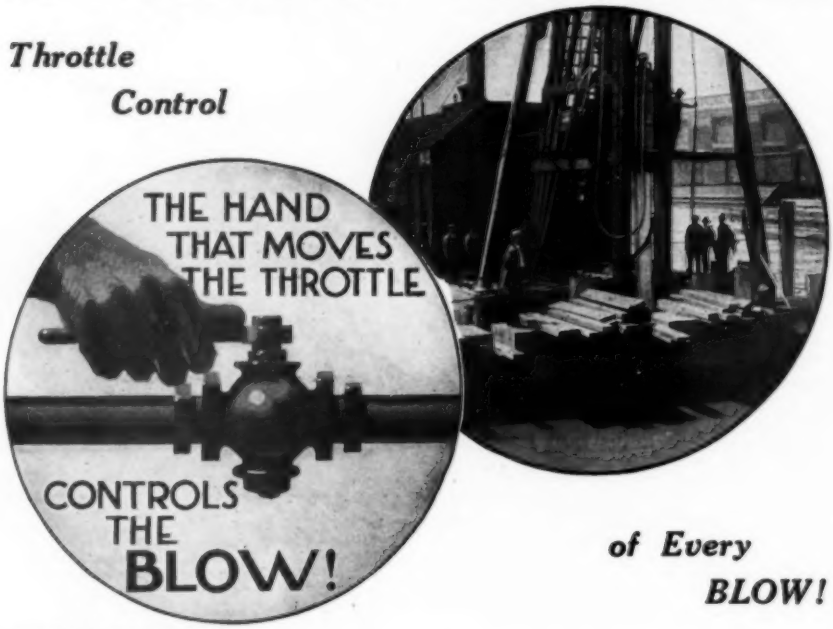

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Western Structural Co., Moline, Ill.

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(See Contractors' Used Equipment.)

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Darling Valve & Mfg. Co., Williamsport, Pa.
Eddy Valve Co., Waterford, N. Y.
Fairbanks Co., The, New York.
Iowa Valve Co., Oskaloosa, Ia.
Kennedy Valve Mfg. Co., Elmira, N. Y.
Mueller Mfg. Co., H., Decatur, Ill.
Rensselaer Valve Co., Troy, N. Y.
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WAGONS. (See Dump Carts and Wagons.)

WAGON BODIES. (See Dump Bodies)

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Beaver Board Companies, Buffalo, N. Y.
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Upson Co., The, Lockport, N. Y.
Waldorf Paper Products Co., St. Paul, Minn.

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Mueller Mfg. Co., H., Decatur, Ill.
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Pelton Water Wheel Co., San Francisco, Cal.
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Sanderson Cyclone Drill Co., Orrville, Ohio.
Sparta Iron Wks. Co., Sparta, Wis.
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Jackson Mfg. Co., Harrisburg, Pa.
Lansing Co., Lansing, Mich.
Sidney Steel Scraper Co., Sidney, O.
Sterling Wheelbarrow Co., Milwaukee, Wis.
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Detroit Steel Products Co., Detroit, Mich.
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Mississippi Wire Glass Co., New York.

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WIRE ROPE. (See Rope, Wire.)

WOOD BLOCKS (See Paving Blocks)

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The Construction of the Yadkin River Bridge

An Eleven-Span Highway Structure with Seven 150-Foot Two-Rib Arches with River Piers Built in Puddled and Sheeted Coffer-Dams with Concentric Bracing Frames Assembled on Shore and Placed by a 900-Foot Cableway

By Frank W. Skinner
Consulting Engineer, New York City

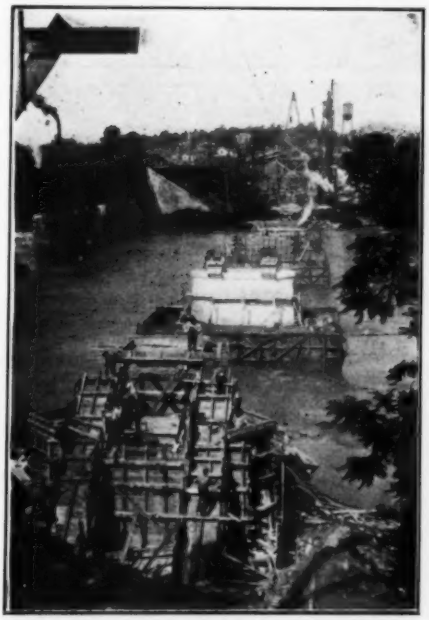
THE Yadkin River bridge, which is Project 673 of the North Carolina State Highway Commission, is an interesting structure, including seven 150-foot hingeless concrete arch spans flanked at each end by two 40-foot deck girder spans masked by fascia screens giving an arched effect. It carries a 20-foot roadway except on the end deck span, where it is widened to 30 feet by curving the handrail. Each main span has two reinforced ribs, 4 feet 6 inches by 4 feet 3 inches at the skewbacks and 2 feet 6 inches by 4 feet 3 inches at the crown, with a rise of approximately 30 feet. This brings the roadway 56 feet above water-level and keeps the spring line above flood elevation. The bridge crosses the Yadkin River between Davidson and Rowan Counties on Route No. 10, near Yadkin, N. C., and is under contract to the Hardaway Contracting Company for about $190,000.

Except for the north abutment pier and bents, the foundations are all carried to solid rock at a maximum depth of about 10 feet below water-level. The river has a low-water depth of not more than 5 feet and a current of about 3 miles per hour. The bed is solid rock with little earth or gravel on top.

The principal quantities include about 6,500 yards of concrete of all classes, 600,000 pounds of reinforcing steel, 3,335 square yards of asphalt wearing surface, 9,300 barrels of Lehigh portland cement, 750,000 feet of form lumber, and 200 yards of rock excavation.

Contractor's Equipment

The contractor's equipment includes a 900-foot Lidgerwood cableway and engine with three 110-foot steel tower derricks with two-drum Lidgerwood hoisting engines with extra large and stiff swinging gear to operate the large bull wheels for handling plants and equipment. Stone and sand are received on a side track at the south end of the bridge, unloaded from cars to the stock pile and into



VIEW ACROSS THE BRIDGE SITE, SHOWING PIERS UNDER CONSTRUCTION, AND CABLEWAY

STEEL IN PLACE IN ARCH RIBS OF SPAN ONE

bins over a 1-yard Smith mixer by two Hayward 1-yard clam-shell buckets. The capacity of the stock pile is about 20 cars of stone and 15 cars of sand, which are reclaimed by the buckets to bins over the mixer holding about 30 yards of stone and 15 yards of sand. A cement house adjacent to the siding and in range of the unloading derrick will stock about 6 cars of cement. A carpenter shop with complete sawmill outfit was installed and a working yard established adjacent to it where practically all the lumber was planed, dressed and cut to length. Many forms were built here in sections and transferred to position by the derricks and cableway.

Coffer-Dams

Excavation for the river piers revealed very few boulders and little sand on top of solid rock, which was a granite broken by many seams. The land piers were excavated inside of a sheet coffer-dam made of 2-inch Wakefield piling driven to solid rock. All river piers were built in coffer-dams sheeted with a double line of 1-inch lumber hand-driven with sledges to broom against the rock in the river bed. This sheeting was spiked to frames made of three lines of 6- by 6-inch timbers on 4-foot centers.

The frames were built complete on the shore, transported by the cableway, sunk and anchored in place to one of three 2-yard buckets, previously placed and filled with stone. The inside frames were 20 by 30 feet, and the outside frames were made large enough to enclose a clay puddle wall from 6 to 8 feet thick, depending on the depth of the river. Usually the coffer-dam frames were set, sheeted and puddled ready to unwater in about 5 days, but it could have been done in about 3 days' continuous working time.

The coffer-dams were unwatered and easily kept dry by 4-inch Emerson pumps. The river bed was cleaned of sand and boulders, and from 2 to 4 feet of rock was removed by drilling with four E44 Ingersoll-Rand drills and blasting to securely anchor the piers against sliding.

Foundations

Test holes were drilled in each foundation to determine the nature of the underlying strata. In every case except in the two south piers, it was found that the rock was solid, broken only by very small seams. At Pier 2 open seams were found from 12 to 16 feet below the rock surface. Eight holes were drilled in the foundation to the depth of these seams and capped with 2-inch pipes, through which water was pumped until the seams were washed clean, after which they were grouted under pressure until all pipes showed full.

Pier 1, the south abutment pier, rests on a decayed granite foundation and was redesigned when solid rock was not found as expected. Test holes showed rock from 12 to 15 feet below the rock line of all other piers, and tests were made in the excavation of this pier to determine the bearing capacity of the soil. A load of 5 tons per square foot revealed very little settlement, and a heavily reinforced slab, 30 feet wide with horizontal and inclined faces, was concreted in the foundation pit to receive the two buttresses of the arches. The piers are solid to the springing line of the arches and hollow above, where they are made with four columns tied together transversely with beams, and longitudinally with 9-inch walls which close the up-stream and down-stream faces, giving them a solid appearance. The piers contain 2,200 yards of 1:2½:5 concrete.

Arch Centering

The contractor, to provide centering for the simultaneous concreting of five arch spans, used standard Blaw-Knox steel centers made up of two curved steel trusses, built in sections, braced and tied together, one truss under each rib. The trusses were assembled on shore in pairs, carried out on the cableway, erected and guyed, until one half-span was assembled. A timber false-work tower, erected under its crown panel, supported the upper end of this half-center while the remaining two single semi-trusses were brought out one at a time and set in place. They were then braced and tied together and the false-work tower removed to

use for other spans. The maximum truss weight thus handled by the cableway was 8 tons. This type of centering kept the river channel practically free from false work, and no damage resulted from the 13-foot maximum high water which has occurred since the work has been under way.

The arch centers support three lines of doubled 2- by 10-inch stringers laid flat parallel to the trusses under each rib on 6- by 8-inch cross-beams. The stringers take the curve of the intrados and are sheeted with 2-inch shiplap lagging.

Concreting Arch Ribs

Each arch rib is concreted in five sections and poured in three operations—first the crown section of both ribs on one span, next the haunch or skewback sections, both sides of the crown on both ribs, and finally the closure section of both ribs, both sides of the crown. The total concrete in both arch ribs for one span is 22 yards and is poured in about 3 hours. The four haunch sections, 75 yards, are poured in 7 hours, and the closure section, 61 yards in 6 hours, thus making about 16 hours actual pouring time for the 158 yards of 1:2:4 concrete in the two 150-foot ribs.

Concrete was poured on the ribs of only one span at the same time, but after the crown sections of one span were poured, the crown sections of the second span were next poured; then the haunch sections of the first span, the crown sections of the third span, the haunch sections of the second span, and, finally, in the sixth operation, the closure sections of the first span.

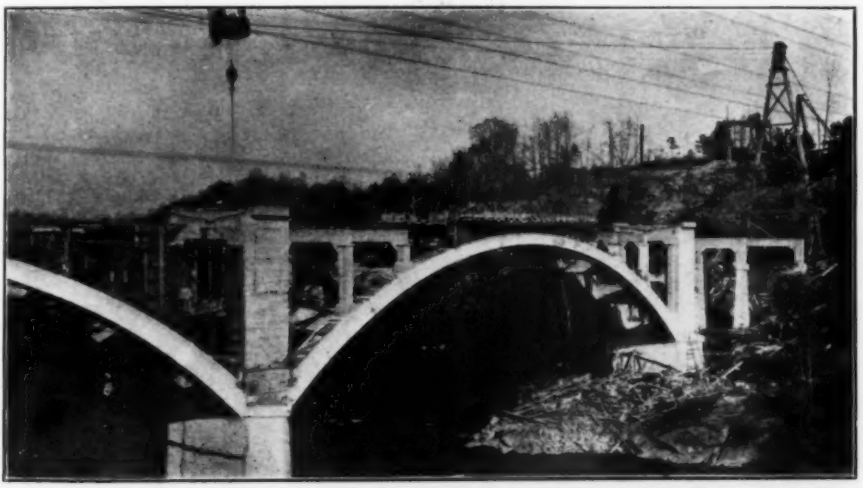
After the first span was completed, the crown sections of the fourth span were poured, then the haunches of the third span, and the closures of the second span. The remainder of the seven main spans were similarly concreted, progressing always uniformly in the same direction and in the same order with the successive spans.

The tenth operation was the crown of the fifth and last span. This arrangement provided for the completion of the third span and the pouring of the haunches in the fourth span before removing the centering under spans one and two, and insured sufficient reaction for the unbalanced horizontal thrusts. Crown sections of any adjacent spans are poured ahead of the haunch sections of a span, and a crown and haunch section must be poured ahead of a closed arch. The concrete was delivered from the mixer to two 1½-yard bottom-dump buckets, handled by a derrick to the cableway and thence dumped directly to the forms.

During the pouring of the arch ribs there was from 2 to 3 inches of settlement in the steel forms, but no settlement or deflection was observed after the centers were struck, usually when the rib concrete was 28 days old. The superstructure contains 200 yards of 1:1½:3 hand-rail concrete and 4,100 yards for all other parts.

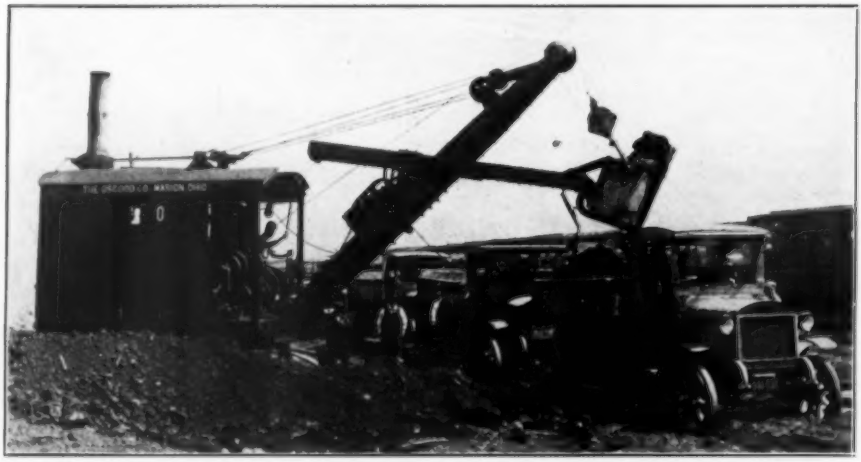
Work on the job was commenced in January, 1923, and the first concrete was poured in May, 1923.

The maximum force employed was about 80 men. Charles M. Upham is chief engineer of the North Carolina State Highway Commission, and W. F. Morrison is resident engineer on the job.

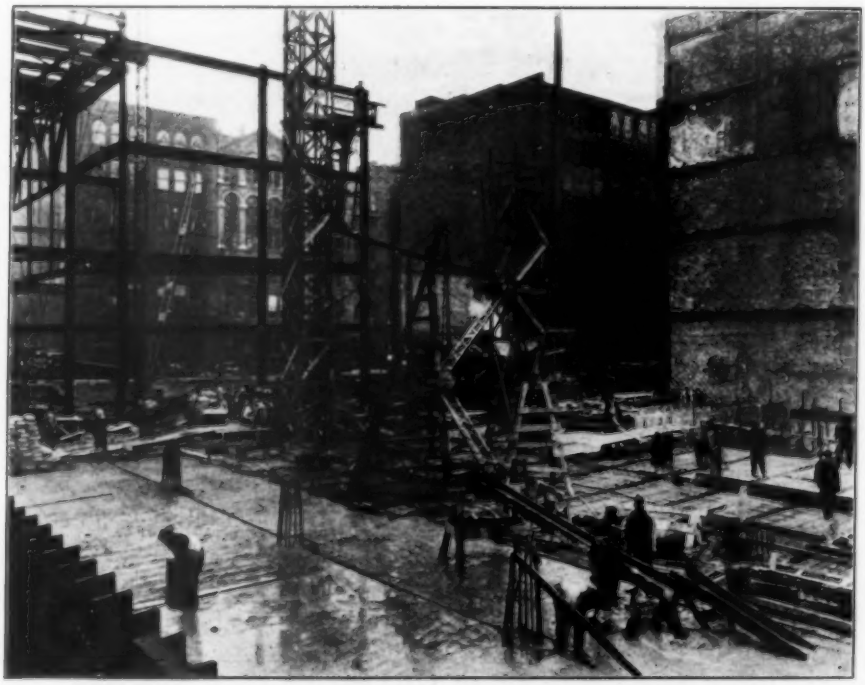


PREPARING TO POUR THE CROWN SECTION OF SPAN ONE

Equipment at Work on Excavating and Building



OSGOOD STEAM SHOVEL LOADING GMC TRUCKS OWNED BY JOHN FLY, CONTRACTOR, ROCHESTER, N. Y.



THE NEW $2,500,000 LOEW THEATRE IN ST. LOUIS UNDER CONSTRUCTION

The picture shows a 7-S Smith one-bag concrete mixer in use by the Boaz-Keil Construction Company, St. Louis, pouring concrete on this job. Two of these mixers, purchased from the George F. Smith Company, St. Louis, Mo., were used to pour all the concrete for the building

Legal Points for Contractors

These brief abstracts of court decisions in the contracting fields may aid you in avoiding legal difficulties. Local ordinances or state laws may alter the conditions in your community. If in doubt, consult your own lawyer

Edited by A. L. H. Street, Attorney-at-Law

Right to Excuse Non-Performance of Contract on Ground of Impossibility

Speaking of the rule of law that failure to perform a contract may be excused on the ground of impossibility to perform, the Vermont Supreme Court observed the other day in the case of City of Montpelier vs. National Surety Company, 122 Atlantic Reporter, 484:

"To warrant application of that principle, the impossibility must consist in the nature of the thing to be done and not in the inability of the party to do it. The general doctrine is well settled that, when a party contracts to do a thing without qualification, he is not discharged from his liability under the contract because of a contingency subsequently arising making it impossible for him to do that which he has agreed to do. The principle deducible from the cases is that if what is agreed to be done is in nature possible and lawful it must be done, or, otherwise stated, the promisor takes the risk within the limits of his undertaking of being able to perform."

Effect of Bond to Avoid Attachment of Liens

A bond given by a general contractor to an owner to indemnify against liens filed against the property on account of the improvement is limited in its application to liens of materialmen and subcontractors, and does not preclude the general contractor from enforcing a lien for compensation due him, holds the Missouri Supreme Court in the case of Allen Estate Association vs. Fred Boeke & Son, 254 Southwestern Reporter, 858. The Court said:

"To say that one capable of contracting would enter into an agreement requiring skill, labor, and the immediate expenditure of much money, and in this agreement free from obligation the owner of the property to be benefited, is absurd. What this bond means, when it provides that the contractor will hold the owner harmless from mechanic's liens, is that if the obligees, the Ottawa Realty Company and the Allen Estate Association, pay the obligors, Fred Boeke & Son, the contract price for the work done and materials furnished, the bond will protect them from any liens that may be filed by material-men and subcontractors."

Massachusetts Decision on Substantial Performance of Contracts

"In this commonwealth," observed the Massachusetts Supreme Judicial Court in the recent case of Smedley vs. Walden, 141 Northeastern Reporter, 281, "a plaintiff who has substantially performed a building contract except in some comparatively slight deviations, or in some slight unessential variations, may recover" the reasonable value of services and materials furnished, as distinguished from recovery of the agreed price, "if he can show an attempt to perform it with such an 'approximation to complete performance that the owner obtained substantially what was called for by the contract, although it may not be the same in every particular, and although there may be omissions and imperfections on account of which there should be a deduction from the contract price.' . . . And 'the question whether there was a substantial performance of the contract is to be determined in reference to the entire contract, and what was done or omitted under it.' . . . But it is also the settled law of this commonwealth that an intentional departure or wilful default in the performance of a substantial stipulation of a contract is in itself such bad faith as bars recovery, regardless of the presence or absence of an intent to gain or obtain some advantage thereby."

Validity of Contracts Made with Government Officials

"The courts have regarded government officers and agents, when dealing for or with the government to which their services are due, as occupying a position similar to that of a guardian transacting business for or with his ward," said the United States District Court for Southern District of Ohio in the recent case of United States vs. A. Bentley & Sons Company, 293 Federal Reporter, 229. "It is also true that persons dealing with government officers and agents, whether such officers or agents represent a municipal, a state, or the national government, are in duty bound to inquire as to and to take notice of the extent of such officers' and agents' authority and power, and are to be held to a recognition that such officers and agents must observe fairness and good faith as between themselves and the government. . . . Both are supposed to exercise honesty and common sense. . . . But no cases have been found which hold that a person who is not an officer or a representative of the government occupies in dealing with it the position of or a position akin to that of a guardian or trustee. When the government enters into a contract with an individual or corporation, it divests itself of its sovereign character as to that particular transaction and takes that of an ordinary citizen and submits to the same law as governs individuals under like circumstances."

Liability of Contractors for Injury to Persons on Premises

Defendants, contractors, were not liable for injury to plaintiff, who unexpectedly appeared on premises where a building was being dismantled and who was injured through a fall of brick, according to the decision reached by the Tennessee Supreme Court in the case of Worsham vs. Dempster (255 Southwestern Reporter, 52.) It appeared that plaintiff went to the building to remove machinery belonging to him, and responding to a contention made on his part by his attorneys that he had a right to do this, the Supreme Court said:

"That may be conceded, but if he entered for that purpose he did so as a licensee, and not as an invitee. He did not have an iota of right or interest in that basement. He certainly was not there by invitation of the defendants. They knew nothing about his machinery; he had never mentioned the matter to them. The only duty they owed him was not to wantonly injure him. They certainly owed the plaintiff no higher duty. The cellar had been torn up and lumber, etc. (old floor), piled therein. It was dark down there. . . . . No freight had been received by any one through the back door since the building had been turned over to the defendants.

In these circumstances the defendants could not reasonably expect the plaintiff to suddenly emerge from that door, and applying the test or rule set forth above, it cannot be said that the defendants either expressly or impliedly invited the plaintiff to the basement or through the basement door."

Effect of Statutory Requirement for Award to Lowest Bidder

To justify rejecting the lowest bid on public work, under a statute requiring award to the lowest responsible bidder, there must be something inducing a reasonable belief of irresponsibility before there may be a valid rejection, held the New Jersey Court of Errors and Appeals in the recent case of Paterson Contracting Company vs. City of Hackensack, 122 Atlantic Reporter, 741. In this case, which involved the construction of sewers, the Court said:

"To bid upon a contract of this character requires considerable work on the part of the bidder in studying the specifications, making estimates of the amount of excavation to be done and materials required, obtaining bids for the materials, making tentative contracts to cover the materials and necessary labor, etc. These matters required the expenditure of money. To encourage contractors to submit bids for public improvements should be the aim of every community. Numerous bidders create competition. Competition lowers the cost. If bids are rejected arbitrarily or capriciously, contractors will not take the time and expend the money necessary to submit proposals. They will infer favoritism. This will result in fewer bidders and higher bids. The statute providing for the award of a contract for a public improvement to the lowest responsible bidder was enacted for the protection of bidders. To reject the bid of the lowest bidder, there must be such evidence of the irresponsibility of the bidder as would cause fair-minded and reasonable men to believe that it would not be for the best interest of the municipality to award the contract to the lowest bidder."

Trade Customs Cannot Be Shown to Contradict Express Contract

In an action for damages for failing to complete delivery of 1,190,000 bricks, and in affirming judgment in favor of the buyer, on the seller's appeal, the New Jersey Court of Errors and Appeals said (Rogers vs. Edward M. Rodrock Company, 120 Atlantic Reporter, 1):

"The appellant next argues that it was error to refuse defendant's offered proof that it was a trade custom to limit the amount of material required to be furnished by a specific contract to the quantity of material necessary to complete the building which the contractor was erecting; in other words, that a clear and unambiguous contract is subject to be modified by a trade custom in a particular locality. This was properly excluded. The contract in express terms required the delivery of a given number of bricks at a fixed price, and—'where there is a contract, either by parol or in writing, its terms must fix the rights of parties, and it cannot be contradicted by proof of usage or custom.' Schenck v. Griffin, 28 N. J. Law, 462."

Substitution of Materials Under Building Contract—Owner's Satisfaction—Substantial Performance

A builder cannot justify failure to use the kind of flue lining and paint required by his contract on the ground that the materials used are just as good as those agreed upon. A contractor who substitutes iron, for lead, water pipe, will be required, in a suit on the contract, to make allowance for the cost of laying lead pipe as provided in the agreement, and not merely for the difference between the cost of the two kinds of pipe. A contract requiring performance to the owner's satisfaction entitles him to make any objection that is not unreasonable or capricious. The legal principle which entitles a builder to recover on substantial performance of a contract requires exercise of good faith on his part to comply with his agreement. (Pennsylvania Supreme Court, Morgan vs. Gamble, 79 Atlantic Reporter, 410.)

Effect of Contract Silent as to Time of Payment, etc.

If a contract for work is silent as to the time for completion, character of the work and time for payment, the law implies that it shall be performed within a reasonable time in an ordinarily skillful manner, and that payment shall be made within a reasonable time after completion of the work. (Washington Supreme Court, Stanton vs. Dennis, 116 Pacific Reporter, 650.)

Bonds as a Gage of the Contractors' Responsibility

By N. F. Helmers

Siems, Helmers and Schaffner, Inc., St. Paul, Minn.

SINCE the advent of the present large road-building program in this country, there has been a great increase in public lettings. This means that instead of having the private owner who can select a few contractors whom he deems desirable, practically anyone can submit a figure on public work. It is unfortunate that the novice or the man who has not previously built a certain type of construction always thinks that it can be built for less money than is really the fact.

The private owner has always had a means of selecting the type of contractor he desires. In the past the largest work in the heyday of railroad construction was handled by employers who could select. The highway engineer, the city engineer, or any other public servant, has not that privilege. In most cases he is bound by law to let his work to the lowest bidder who can secure a bond. Happily, in some places, because of the bad results from this type of letting, special legislation has been passed enabling the engineer to require a questionnaire as to finances, experience, equipment and past performance, and to use this information in making decisions of awards. However, in many instances, even when the engineer has this choice, he will be subjected to political log-rolling, because he has hanging over him the prevailing idea that the responsible bidder is the one who puts in the lowest price and can provide a bond to cover any deficiency.

A Resolution Seeking Sane Bonding

Whereas, bond agents are writing bonds for contractors who are obviously incapable of performing their contracts or who have obviously demonstrated that they cannot be relied upon to carry out their obligations in good faith; and

Whereas, the bonding of these irresponsible contractors gives them an unwarranted credit rating, and in the eyes of the public stamps them as responsible bidders; and

Whereas, once this false stamp of responsibility is given by the bonding company to an irresponsible bidder, the engineer or architect is often obliged by a misguided public opinion to award him the contract; and

Whereas, the ease with which the surety bond may be obtained by almost any agency designating itself as a general contractor, enables innumerable persons to embark upon extensive construction projects which they cannot carry through to successful completion; and

Whereas, numerous defaults of these irresponsible companies who can obtain surety bonds bring public censure upon the engineer, dissipate engineering funds, produce an inferior quality of workmanship, and keep public construction in a demoralized condition; and

Whereas, these numerous defaults have greatly increased the rate of bond premiums, thereby adding to the cost of construction paid by the public, and

Whereas, operations of these injudiciously bonded bidders react injuriously upon those contractors who faithfully perform their obligations, create suspicion and distrust of all contractors, and retard the development of companies that are willing and able to render satisfactory construction service; and

Whereas, the bonding of bidders unqualified by either experience, personal integrity, or financial soundness to assume their contracts is preventing the development of constructive service and the adoption of ethical practices which are essential to the establishment of construction as an orderly industry; therefore

Be it resolved, that the Associated General Contractors join with the American Association of Highway Officials and representatives of the surety companies for a complete and impartial analysis of the bonding situation, seeking to find a proper solution for the issues confronting both the bonding companies and the contractors.

Who Is the "Lowest Responsible Bidder"?

The lowest responsible bidder must be a man who has the necessary reserve back of him to finance public works properly, who has available the necessary equipment to complete the work properly, who has the necessary organization to handle that equipment and to do the work, and who has the known ability to properly supervise and push that work to its ultimate conclusion within the desired time limit. When a bonding company essays to underwrite the lowest responsible bidder on a piece of work, it is taking a serious responsibility. In the last analysis, the state, taxpayers and public authorities are the ones to say who is a responsible bidder or who is not. As the matter stands today, the attitude of the bonding company in connection with that little phrase, "the lowest responsible bidder," is the rock on which the construction business of the United States is being dashed to pieces.

Some fourteen years ago when I entered the contracting field on a very small scale, I found that the bonding company which was willing to handle my case felt it necessary to inquire carefully into what work I had done before, and in a general way as to my ability as a construction man and as to whether or not I had knowledge of costs to sufficiently justify my bond. These points were apparently of as much or more value than the funds I had available. If that were the situation to-day, I do

not believe we would be trying to make a case against the bonding companies. But what do we find? We find that because of poor risks taken by the bonding company the premium has been increased over 1,000 per cent, so that it is now 1½ per cent of the total cost of the work. We learn that field agents are being paid an unreasonable percentage, amounting to as much as 25 to 35 per cent of the total premium, in order to secure business. This method blinds them to any idea of safeguarding their employer, the bonding company, and in many cases we are certain that the bonding company accepts a risk in what looks good on a bare statement of facts, but which is not such in reality. At a recent letting a gentleman connected with one of the large engineering papers of this country happened to be in a hotel in a city where a letting of a large construction project was taking place. He was approached by a bonding salesman who asked, "Are you bidding on this work?" He replied, "Well, I have not really decided as yet." To this the bonding salesman replied, "Well, if you are, I have it all fixed up to take care of your bond."

Reckless Bonding Leads to Litigation

This way of getting business can have only one outcome, namely, that a bonding company trapped through lack of foresight on the part of its staff or its agent is prone to take unfair advantage of technicalities, and in very many cases it has therefore been necessary for the owners to bring suit against the bonding company to force it to comply with what it had already agreed to do, namely, underwrite the work. Any fair underwriting of that work does not merely mean to complete it, but to complete it on time. How many cases have you heard of when work has stopped through default and it has been necessary to make arrangements with a bonding company, and the work has been finished on time? Indiscriminate low bidding by inexperienced people, underwritten by careless bonding companies, has caused a very serious situation in the construction field. Old construction companies with established reputations are dropping out of the field of public construction. Engineers in charge of such work are being forced to the conclusion that such bonding has no real value.

These engineers, and contractors in general, are seeking an outlet which will give the experienced contractor an opportunity to get the work. They can clearly see the loss which constantly occurs from the policy of getting a low bidder that doesn't pan out.

At a joint meeting of the Committee on Cooperation with Contractors and a committee of the Associated General Contractors of America, held in New Orleans on December 4, 1923, certain matters pertaining to highway costs and contracting practices were deliberated and conclusions reached as noted below:

Surety Bonds and Bonding Practices

"The expansion of hard-surfaced highways has been attended by such an influx of new construction companies into this field that many contractors have secured contracts which they were incapable of performing. Much unnecessary engineering expense, friction, improper conduct of construction, expense to taxpayers in being deprived of the use of roads, and other unfavorable contingencies are resulting from the bonding of irresponsible contracts.

"By reason of their ability to obtain a corporate bond (and the practical credit which goes with a guarantee of labor and material costs) many concerns inadequately experienced have been able to secure and embark upon the execution of large projects and have subsequently defaulted. Engineers would not willingly award a contract to a construction company known to be incapable or unwilling to execute the work satisfactorily, yet situations frequently arise where departments cannot publicly justify themselves in refusing to accept the proposal of an unqualified company. This condition appears to result from the ease with which almost any concern professing to be a construction company can obtain a performance bond.

"To the layman unfamiliar with the difficulties involved, where a highway department is attempting to carry out a definite mileage on schedule, a financially strong surety is regarded as ample safeguard to the state. In view, however, of the delay and legal procedure frequently incurred by default, a corporate bond has often proved an inadequate and expensive form of protection. Some means is needed for minimizing the operating of irresponsible contractors on highways and for encouraging the growth of more responsible concerns.

"Most highway departments now have the authority to reject the bid of an irresponsible company, but in practical effect such authority can seldom be freely exercised. As long as irresponsible bidders can secure a bond, and the public is willing to accept that bond as a guarantee of responsibility, the highway official will not be in a position to exercise his rightful authority. In other words, he cannot judiciously refuse in many instances to award a contract to the incapable contractor while this practice of promiscuous bonding continues.

"The present situation is one which appears to have passed in a great measure beyond the control of bonding company officials, and to have resulted primarily from the commission system of compensating underwriting agents and the freedom exercised by these agents in writing bonds. Agents are reported as receiving commissions amounting to as much as 25 to 35 per cent of the total premium. Local competition between the agents of different companies is apparently keen. Their primary interest is often manifested chiefly in securing a bond for the lowest bidder, not because he is competent, but merely in order to secure the compensation involved. This tendency has naturally resulted in heavy expenditures by the surety companies, who have met increasing losses by increased premium rates. Within the last 20 years the cost of premiums has risen, in some instances more than 1,000 per cent. The practice has apparently been to bond

almost any low bidder and to let the increasing premiums cover the losses from default. The public has paid the bill.

"This situation could not occur in a truly competitive industry where the demand for a commodity is influenced by the prices charged. In the public bonding field, because of urgent demand, where work will proceed almost independently of a bond premium rate and because of a standard rate, it has been possible to increase the rate to a point where such increases mean millions of dollars annually to the public, but which have not increased the net earnings of the bonding companies in proportion. If the mere payment of a high premium were the only element involved, the matter might be of less concern to engineers and public officials, but a more vital factor is involved by the disruption of highway programs, delays in building, and expense resulting from defaults. State highway officials can exercise an effective remedy by encouraging a measure of competition in the surety field. Such competition would tend to reduce bond premium rates, this necessitating more judicious bonding of contractors, which is the main objective to be sought.

"If the surety companies cannot devise a means of eliminating detrimental practices on the part of agents, and of faithfully performing their stewardship to the state, the force of public opinion will eventually demand that their house be placed in order. Therefore it is proposed that before present conditions become more aggravated, representative bonding officials be invited to meet with representatives of The American Association of State Highway Officials and Associated General Contractors to devise, if possible, an amicable and cooperative method of relieving the present situation.

"As a means of enabling highway officials to ascertain responsibility of bidders with respect to a given project, various states have devised questionnaires designed to reveal the bidder's qualifications. These forms, varying considerably in detail, require in general a statement of financial resources, equipment available, experience, and personal references from bankers and public officials. From these the highway official is able to gage more accurately the bidder's ability to perform a given project."

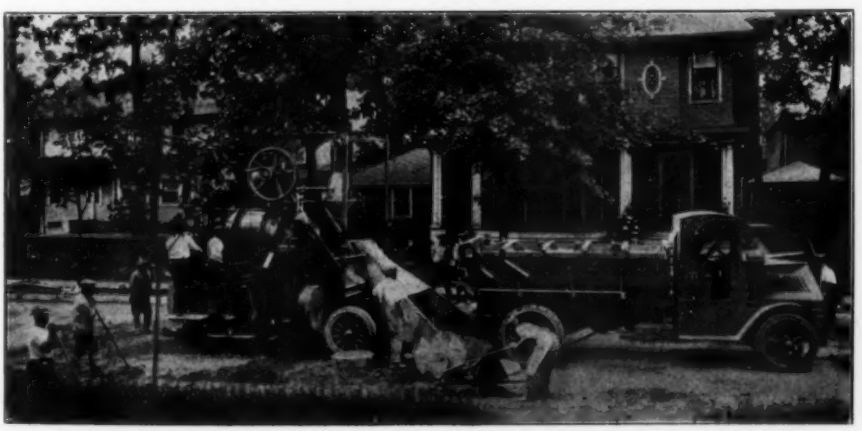
The sad part of it all is that the remedy is so simple. The business can be secured as easily as a good risk as it can be as a bad risk. When the bonding companies learn that it is to their interest to see that the so-called lowest responsible bidder has the skill, integrity and responsibility, bearing in mind that skill necessarily means having a knowledge of costs obtained from first-hand experience, then the contractors will be protected, and the engineers will be protected, and the public will be protected.

ACKNOWLEDGMENT.—From a paper delivered at the Fifth Annual Meeting of the Associated General Contractors of America, Chicago, Ill.

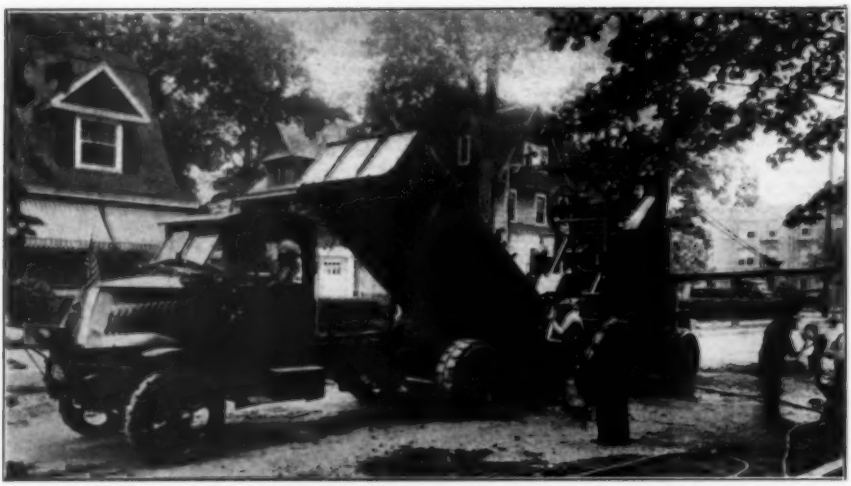
A Road-Building Comparison

Speed of Modern Road Building is Like Magic When Ancient Construction is Considered

DELVING into the annals of ancient highway construction, one is amazed at the amount of time and effort that was expended upon such work. The Appian Way, for instance, longest and best-known of famous Roman roads, was the result of four centuries of grueling work done by thousands of slaves used solely for that purpose. Work was begun on this historical highway in 312 B. C. during the reign of Appius Claudius Caecus,



A FIVE-COMPARTMENT LOAD OF AGGREGATE READY FOR THE MIXER HOPPER



EACH BATCH OF AGGREGATE IS DELIVERED TO THE MIXER SKIP SEPARATELY BY THE TRUCKS

and in the year 100 A. D., after a lapse of four hundred years, ancient records show it was still in the process of construction.

This famous roadway extends from Rome to Brindisi, a distance of 350 miles, and is from 14 to 18 feet wide. Ostensibly it was built to facilitate the movement of troops and army supplies during war times, but, as a matter of fact, it really proved of greater value as an artery of commerce.

The material used in its construction consisted mainly of squared stones which were hauled from the quarry in clumsy wooden carts drawn by teams of oxen. The stones were laid by hand on a specially hard and durable foundation.

Considerable credit has been given to the builders of what seems to be an indestructible road, and they are undoubtedly deserving of the praise, but various writers seem to have forgotten that the frost with which American road engineers are compelled to cope is unknown in the sunny clime of the Roman road district. However, even though the frost factor were eliminated, it would obviously be impractical to expend a whole year in hand inlay construction upon one mile of roadway. The expense would not warrant it and, what is more, traffic of late years has increased so tremendously that were it not for the extraordinary character of the development in highway machinery and the efficient methods of road building which have made it possible for contractors to lay a mile of concrete road in from ten to fifteen days, highway congestion and detours would result in a regular riot.

One of the modern devices, which has effected unusual economy in both time and labor, is the Koehring paver. The machine shown is operated by the Borough Asphalt Company of New York and works in conjunction with a fleet of ten Mack trucks built by the International Motor Company, 25 Broadway, New York.

The body of each truck is divided into five separate compartments, each of which is loaded with dry aggregate sand and crushed stone for one batch, at a central plant located some distance away. Arriving at the scene of construction, the truck backs up to the mixing plant or paver. The body is raised, and by a patented mechanical device one of the compartments, which contains just enough material to fill the mixer, is opened and its contents dropped into the hopper. Cement is then added by wheelbarrow, the hopper raised, and the entire batch poured into a large revolving drum.

To unload the entire five compartments by this new method is a matter of only six minutes, whereas by the old system it took five men working with shovels and wheelbarrows about three minutes to put only one batch into the hopper. In addition to this time-saving factor, manual labor has been practically eliminated, and it means a considerable saving to the contractor.

When the concrete is thoroughly mixed in the revolving drum, the mixture is discharged into a large steel bucket which rides on a movable steel arm about 15 feet long. This enables the bucket of concrete mixture to be dropped anywhere within the radius of the steel arm. Laborers then quickly spread the material, and when the 15 feet of ground is covered, the paving machine moves ahead. By this arrangement it is not unusual to start work on a city block in the morning and have it fully paved with concrete by nightfall. When the concrete has hardened sufficiently, the asphalt is ready to be laid. The partitions in the trucks are then removed and the entire body is filled with asphalt. Incidentally, the bodies of the trucks are insulated with asbestos for this purpose.

Industrial Haulage Successful in Brick Paving

Materials Handled Expeditiously by Contractors on Road Jobs in Edwards County, Ill.

ONE of the most interesting hard-road jobs in Illinois with regard to the problems involved and methods of solution, is the Alan Jay Parrish contract constructed last summer in Edwards County, Illinois. This consists of a contract for building 21½ miles of hard road from Mt. Carmel west to a point 4½ miles west of Albion. The east half of this work is straight concrete with an 18-foot slab, conforming to the standard specifications of the Illinois State Highway Department, and the west half is monolithic brick pavement.

The outstanding features of the work have been the heavy grades encountered and the method of hauling. The first 4½ miles of brick work were over extremely hilly country, there being not even 100 consecutive feet of level grading on the entire strip. The maximum grade was 5 per cent and there were several grades of 4 per cent. According to Rodney L. Bell, who, with Alan Jay Parrish, of Paris, Ill., was contractor for the job, there were two up-hill grades, each one-half mile long, and two down-hill grades of about the same length in the first 4½ miles. Contrary to general belief, it was found to be just about as hard to get the trains down-hill as to get them up-hill.

Transportation Problems

The problem was one of transportation, although there were other details to be handled. It was easy enough to get men who could mix, but the big job was to maintain the hauling schedules and keep materials at the 21-E Smith mixer. It is safe to say that contractors less experienced and responsible would have considered industrial haulage out of the question because of the heavy grades. Messrs. Parrish and Bell, however, were afraid to trust to motor truck transportation on the clay hills, so after analyzing the situation carefully, they installed industrial haulage.

For motive power on the heaviest grades they used a 12-ton Shay-geared steam locomotive. Plymouth gasoline locomotives did the rest, six of them being of 3-ton capacity and one of 7-ton. Ninety-five Western road-builders' cars and 140 batch boxes of 33 cubic feet capacity were installed for the hauling.

The Brick Pavement

The brick pavement has been completed. The proportioning plant for the base course in the brick pavement was set up at Albion in the yard of the Albion Brick Shale Company, from which there was a dead haul of one mile. Brick pavement requires cement, sand and gravel for the base, and special sand and cement for the grout filler, as well as brick for the surfacing. All of the material must be delivered to the job with regularity. The contractors carried on all operations at the same time, keeping the finished pavement as close to the mixer as possible. The brick surface was laid and grouted to within 100 feet of the mixer which was mixing and pouring the base.

Batch boxes on cars operating on industrial trucks were used in the ordinary way for hauling the aggregate and the grouting material. For hauling brick, Western 1923 model heavy-duty cars were equipped with home-made platforms and each made capable of hauling 5 tons. Material was hauled in trains of eight cars each, three cars of brick and five cars of concrete aggregate and cement. On arrival at the mixer, the cars of brick were pushed back to where the brick could be handled, while the ten 5-bag batches on the remaining cars were being unloaded into the mixer. The mixing of a batch required one minute, and the han-

BRICK PAVING ON THE ALAN JAY PARRISH CONTRACT IN EDWARDS COUNTY, ILL.

Three heavy-duty Western cars carrying 15 tons of brick, and five cars carrying ten batches of aggregate made up a unit train on this job

LAYING THE BRICK PAVEMENT

Note the special mixer for mixing the grout filling for the joints. In the left background are the industrial cars loaded with special material for grout

dling of the boxes brought the average up to a minute and a half, or fifteen minutes for unloading the ten batches carried by the train. It required fast and steady work on the part of the men who were handling the brick to keep up.

At the time the photographs shown were taken there was a 4¼-mile haul. The average haul on the entire job was about 2¼ miles. The maximum daily production was 804 linear feet of brick pavement; the maximum weekly production was 4,394 lineal feet. The average daily production was 485 feet of brick. After the work had advanced beyond the heavy fills, an average of 576 feet of brick was maintained for 35 days, until the brick pavement had been completed, and 5,260 linear feet of brick pavement 18 feet wide, approximately one mile, was laid in seven consecutive days. While the brick average is only fair compared with normal jobs, the progress was very satisfactory, considering the heavy and almost continuous grades encountered.

Mr. Bell stated that the average daily output was not a fair sample of the work of the concrete mixer, for during most of the summer it was running only a little over half the time, so that the average was not a fair statement of what the machine can do.

The concrete pavement had not been completed when the work shut down for the winter. The plant was set up at Belmont and the unloading facilities consisted of two Erie cranes and the customary bins. The dead haul is a half-mile. The maximum daily output of concrete was 842 linear feet. A 1:2:3½ mix is used for the concrete pavement, and a 1:3:5 mix for the concrete base under the brick pavement.

Two Dunn tamping machines were used on the brick paving, one on a concrete base and one on the surfacing.

TWO FINISHING MACHINES AT WORK ON THE EDWARDS COUNTY ROAD JOB, ONE WORKING ON THE CONCRETE BASE AND THE OTHER TAMPING BRICK

Manufacturers ---- Distributors ---- Consumers

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Equipment Standardization

By K. B. Noble

President of The K. B. Noble Company, Hartford, Conn., Past President of Associated Equipment Distributors

EQUIPMENT standardization has long been the dream of every individual associated in any way with contracting, but to crystallize a workable plan of standardization in an industry of so many ramifications is a tremendous task. Back of the idea of standardization merit is essential; there must be a plan that can ultimately be accomplished providing that the subject is given sufficient publicity; and it must be possible to establish the importance of the move clearly in the eyes of the three big interests—the Manufacturers, the Contractors and the Distributors.

I am quite positive, personally, that the rank and file of the contractors throughout the country have but a slight conception of the attempts that are being made to standardize on equipment, and I believe that broad publicity and a clear statement of the aims will be the quickest means of agitating the subject and bringing to each contractor the realization that if he, individually, will "put his back to the wheel" and do his share, the manufacturer and the distributor will do theirs.

What is this standardization question? How will it affect the contractor and how will it affect me? This is the question that every contractor will naturally ask. I am willing to admit that I cannot answer it in full, and I doubt very much whether anyone else can, but practical instances of what is being attempted in the way of standardization of models and sizes can be given. In some cases this has been done through force of circumstances, and in others because groups of manufacturers who build similar products have realized that they have been spending thousands of dollars each year in manufacturing fifteen or twenty different sizes, models or qualities of equipment at a tremendous expense and overhead, which ultimately passes to the consumer. By co-operation they have been able to eliminate a large proportion of seldom called-for sizes, models and qualities and have standardized on certain units that are in current and practical demand.

This standardization has resulted in a lowered cost to the ultimate consumer; it has been the means of the manufacturer's producing a tremendous volume of fewer types at a greatly reduced cost; it has narrowed the selection of a certain commodity and permitted the contractor to buy more intelligently; it has allowed the distributor who must buy and sell this commodity an economical means of carrying sufficient stock for the trade without tying up unneccessary sums of money and storage space, which means insurance, taxes, and higher selling prices.

Attempts are now being made through the Associated General Contractors, the Mixer Manufacturers Association, and other manufacturing groups to standardize on their particular lines. At this moment it is my understanding that the wheelbarrow manufacturers are reviewing with care and judgment a plan of eliminating a great many designs of wheelbarrows that are seldom called for except for specific cases, narrowing down the selection to a few highly standardized and efficient models.

The Mixer Manufacturers Association is also working toward standardization of the building mixer and the road paving mixer, in order that it may bring about, smoothly and without disrupting present manufacturing plans, the gradual adoption of those sizes, styles and capacities that more nearly fulfill the universal demand. The Mixer Manufacturers probably have a less difficult road to travel in bringing about this condition than many other manufacturers, because with the concrete mixers, efforts toward standardization have been proceeding for a number of years. Other lines in the construction field, however, are entangled in a maze of types, styles and capacities, and, undeniably, these concerns will have to clean house thoroughly.

I remember reading an article not very long ago, written by an eminent statistician, in which he brought out the fact that the line of standardization could be drawn too fine, having a tendency to smother initiative and advancement. I believe that there are many men who will not agree with this statement, and I number myself among them because I cannot conceive of any case where standardization will be other than a great benefit to the contracting industry. Manufacturers will always have the individuality of their particular model, and will be constantly improving this model and thus concentrate on the higher development of a fewer tools, which will unquestionably accomplish more than if their efforts were divided among larger lines of several models that are

seldom in demand.

I believe a permissible instance of this standardization is noticeable in the great accomplishment of the 21E road building paver. Most manufacturers foresaw that this would be the standard machine for a number of years to come, and they concentrated on bringing this particular model to a high degree of perfection, allowing development work on their other models to cease or at least to play but an unimportant part in the program.

The hoisting industry is another example of the breaking down of old rules and policies. There is hardly a state in the Union to-day that is not drifting rapidly toward the gasoline motor for power. The gasoline engine has acquired an unquestionable reputation for reliability, economy and practicability. The prestige of the gasoline hoist in every field of service is rapidly being felt. This has in turn caused radical changes on the part of many hoisting engine manufacturers, and it has meant the scrapping of thousands of dollars' worth of parts, changing entire sales campaigns, and even in many cases changing the ratings of auxiliary equipment. These changes are primarily made because of the need of a more flexible, versatile power unit, and, while not conceived through the idea of standardization, nevertheless influence the standardization of certain specific models and sizes.

It is hard to predict who will profit most by this ultimate plan of national standardization in the contracting industry, but there is little doubt that each branch of the industry will benefit. On one hand, as illustrated by the pavers, the manufacturers will be able to concentrate their highly paid engineering and experimental departments and field service in the development of certain fixed, recognized models. It will cut down pattern expense and manufacturing space, will narrow the purchasing down to a smaller selection of raw materials, and decrease the manufacturing rules and processes in building up a series of limited sizes. It will increase the selling power of a given fixed commodity, will allow quantity production and lessen hand labor in manufacturing and assembling. It will mean that a tremendous advertising expense, cost of literature, price lists, catalogs and innumerable other steps can be reduced to a minimum. All of these expenses eliminated by the manufacturer will mean, through competition, a lowering, not of standards, but of price, and will result in better products throughout.

The distributor of contractors' equipment to-day is faced with the serious problem of rendering service with sales on a commission that is all too inadequate. In comparison with the automobile industry or similar lines, the equipment distributor is actually receiving in gross returns not more than half of what other fields pay their distributors, and yet the distributor is the one outstanding industry that is forced, through custom and the very nature of the business, to render the highest type of service. That service is a vital necessity with every sale of construction equipment is established through the fact that contractors throughout the country rely on the distributor to look after them in the matter of parts and mechanical details. The distributor cannot continue this service on the present margin. This standardization plan will be the realization of one of the distributor's greatest dreams, and will mean that he can, in turn, cut down his unnecessary overhead, can render a more standardized, compact service, and can reduce the tremendous carrying charges in his parts stock caused by the varied nature of the present-day equipment.

The contractor, by limiting his selection of small tools and equipment to certain fixed sizes, can strongly influence the entire standardization plan.

The progress and practical changes of this standardization plan will be given publicity in all the technical papers, and the plan will, as the months pass, gradually assume tangible form. Although it may be a year or more before it takes definite shape with the majority of the construction industry, it is hoped that each contractor will take up his problems with his local association, and through his distributor regulate his purchases along limited lines. Thus he can aid materially in making it possible for the manufacturers to make practical plans.

Miscellaneous Notes

Building Material Prices

DESPITE an increase in demand, building material prices showed but little change during the month. With the exception of common brick, which was somewhat firmer, New York City witnessed a drop in most starting materials. In a few Middle Western cities cement was quoted at slightly higher prices. While the demand for steel has been strong, it has not come up to expectations, and as a result there has been some softening in Pittsburgh prices. Except for a slight flurry in the Dallas market, lumber has been unchanged.—*Monthly Bulletin of S. W. Straus & Co.*

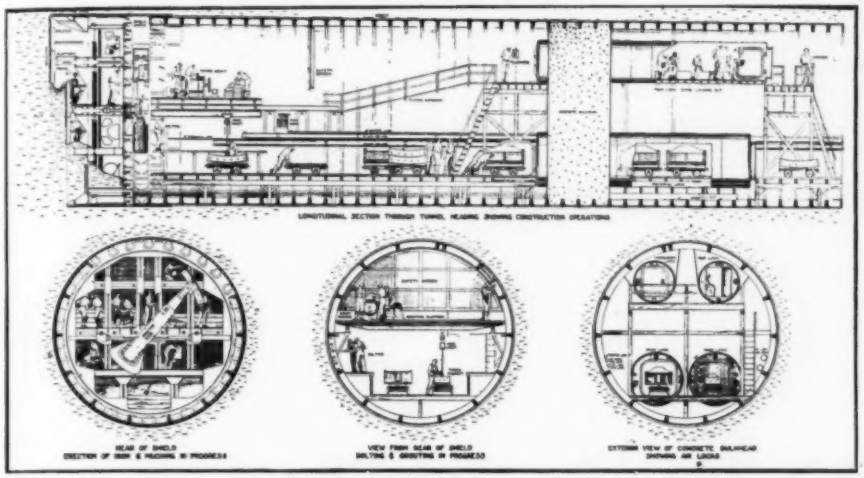
A Shirt-Sleeve Road Show

THE North Carolina State Highway Commission has invited the American Road Builders' Association to stage an open-air demonstration of road-building methods and machinery on June 4-7, 1924, in North Carolina. The Pan-American Highway Commission, consisting of a group of about 40 leaders in the highway movement in the various countries of South and Central America, will be in North Carolina at that time, and these distinguished visitors will visit the demonstration.

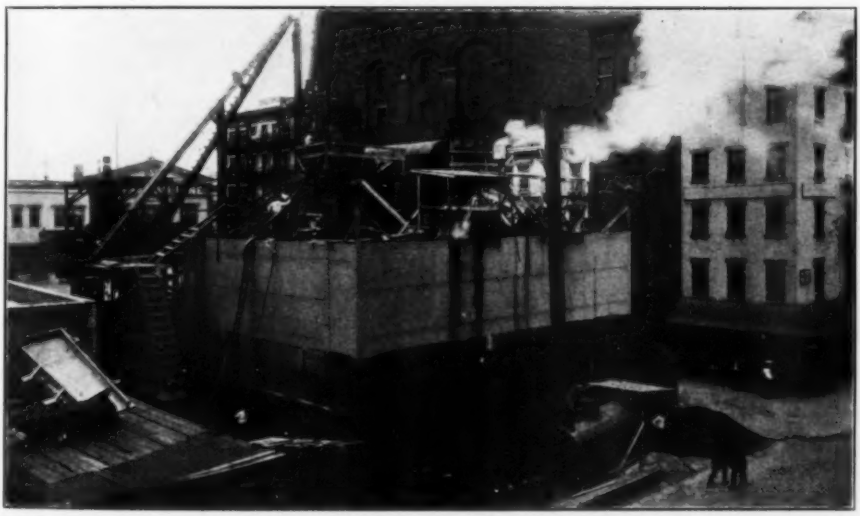
Hitherto all exhibits of road-building machinery in the United States have been held indoors where machinery could not work.

Construction Features of the New York-New Jersey Vehicular Tunnel

Photographs by courtesy of Clifford M. Holland, Chief Engineer, New York and New Jersey Bridge and Tunnel Commissions



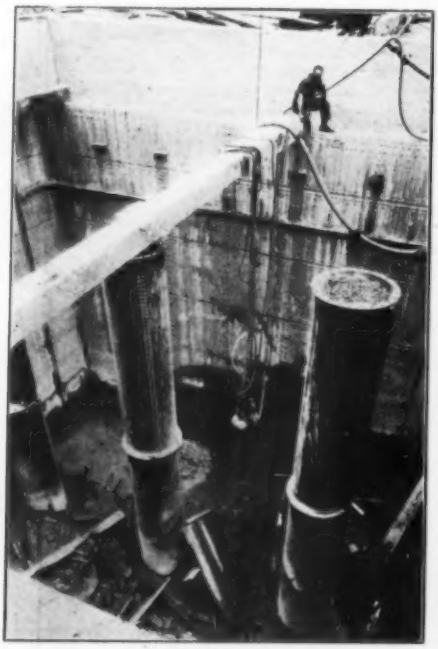
SECTIONS SHOWING CONSTRUCTION OPERATIONS IN THE NEW YORK-NEW JERSEY VEHICULAR TUNNEL



GENERAL VIEW OF THE SPRING STREET SHAFT OF THE VEHICULAR TUNNEL, SHOWING MUCK LOCKS AND MAN LOCKS AS WELL AS LIGHTING EQUIPMENT AT THE CORNERS OF THE CAISSON

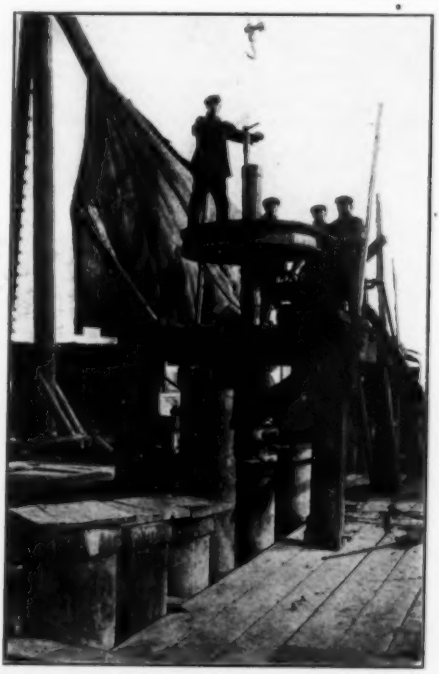
CONSTRUCTION OF CONCRETE PILES, SOUTH RIVER SHAFT, NEW JERSEY

The Ransome concrete mixer discharges into the large bucket which is used to carry the concrete to the hopper which discharges into the concrete pile casings. There were forty-two 24-inch reinforced concrete piles driven to support each caisson



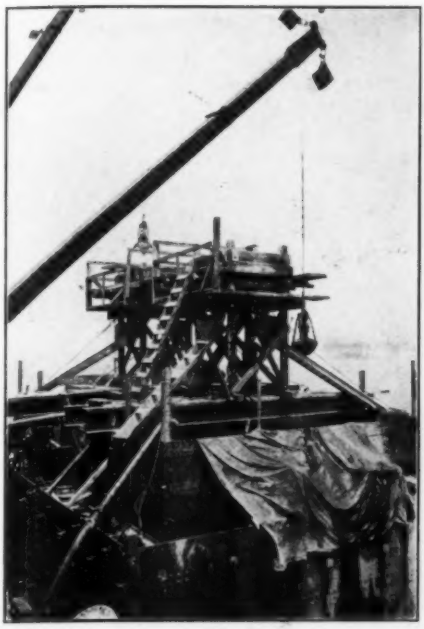
PULSOMETER PUMP REMOVING WATER FROM CAISSON OF THE CANAL STREET SHAFT, NEW YORK

Muck and man lock shafts are shown in foreground. This shaft is the same as the Spring Street shaft in general appearance



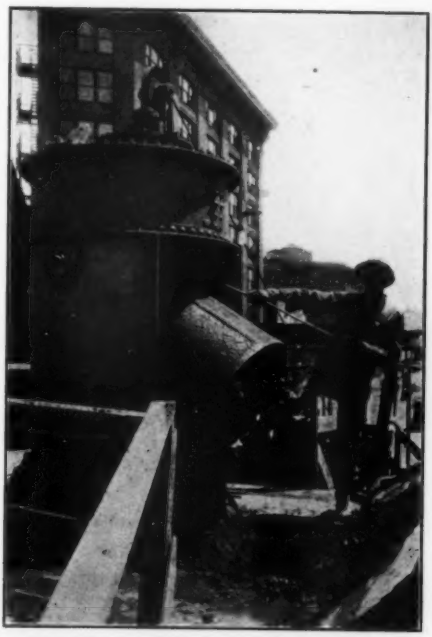
PIPE CUTTING APPARATUS FOR REINFORCED CONCRETE PILES FOR RIVER SHAFT CAISSONS, NEW JERSEY

An engine and bull wheel are used to turn the cutter for cutting off the reinforced concrete piles 120 feet below the top of the pipe



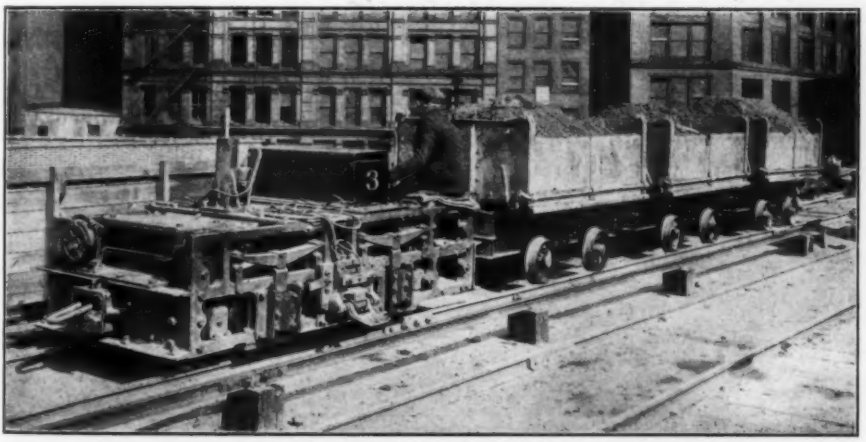
MUCKING OPERATIONS AT NORTH RIVER CAISSON, NEW JERSEY

Two orange-peel buckets were used in mucking out the shaft for the caisson before putting the air on. The two hoppers in the center are concrete hoppers used in concreting the walls of the caisson



REMOVING MUCK FROM THE BUCKET IN THE MUCK LOCK

This picture, taken at the Canal Street shaft, shows the type of muck locks, two of which are located on each caisson. The pressure in the lock is released before the door is opened for emptying the bucket



MOTOR AND TRAIN OF MUCK CARS GOING TO THE DUMP ON PIER 35 FROM THE SOUTH TUNNEL, NEW YORK

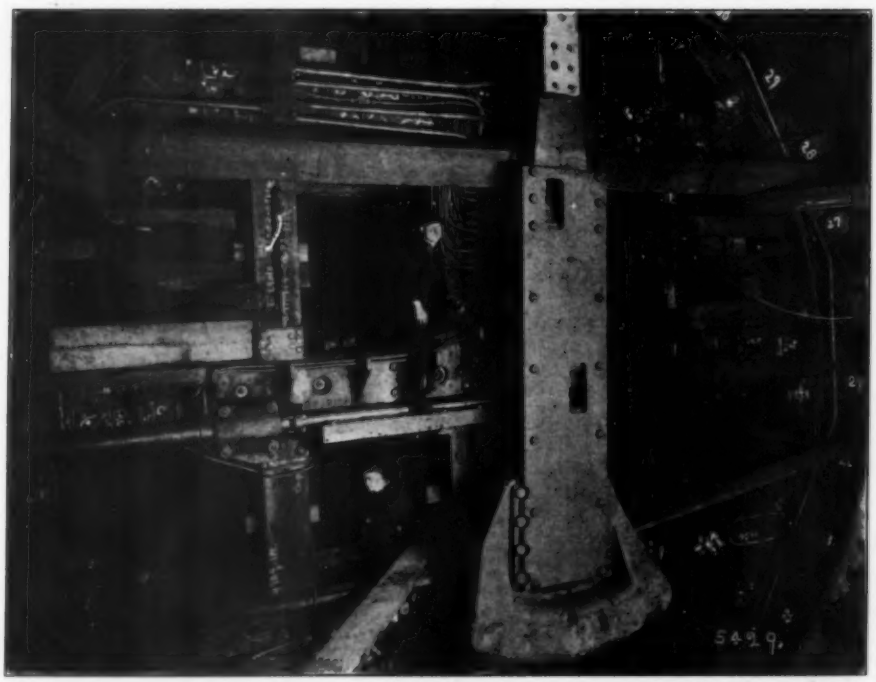
In the tunnel itself Myers-Whaley muck shovels are now being used to advantage, greatly speeding up the work of loading the dump cars over hand labor

ERECTOR PICKING UP A CAST IRON TUNNEL SEGMENT IN SOUTH TUNNEL

Two men of the iron gang are setting the erector in position for lifting a 1½-ton cast iron segment into place

MEN USING RATCHET WRENCH FOR TIGHTENING BOLT

These bolts, 160 to a ring, weighing 10.2 pounds each, are inserted and tightened up before the shove is made for the erection of the next ring



VIEW OF THE TAIL END OF THE CANAL STREET SHIELD AND PART OF THE TEMPORARY RING IN THE CANAL STREET SHAFT JUST BEFORE IT STARTED OUT OF THE SHAFT

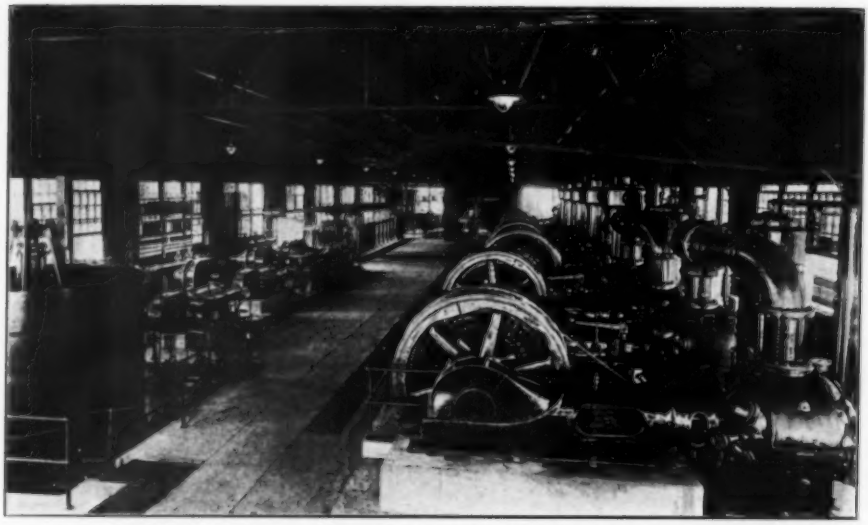
Some of the thirty 10-inch hydraulic rams which shove the shield forward are shown numbered at the right-hand side of the illustration. Each ram exerts a pressure of 200 tons at a working pressure of 5000 pounds per square inch, and has a travel of 30 inches per shove. The counterbalance of the erector which sets the tunnel segments is shown in the foreground

MUCK SAUSAGES COMING THROUGH OPENINGS IN THE SHIELD DURING A SHOVE ON THE NEW JERSEY SIDE

In order to guide the shield and relieve the pressure about 30 to 50 per cent of the compressed silt is permitted to enter the tunnel on each shove

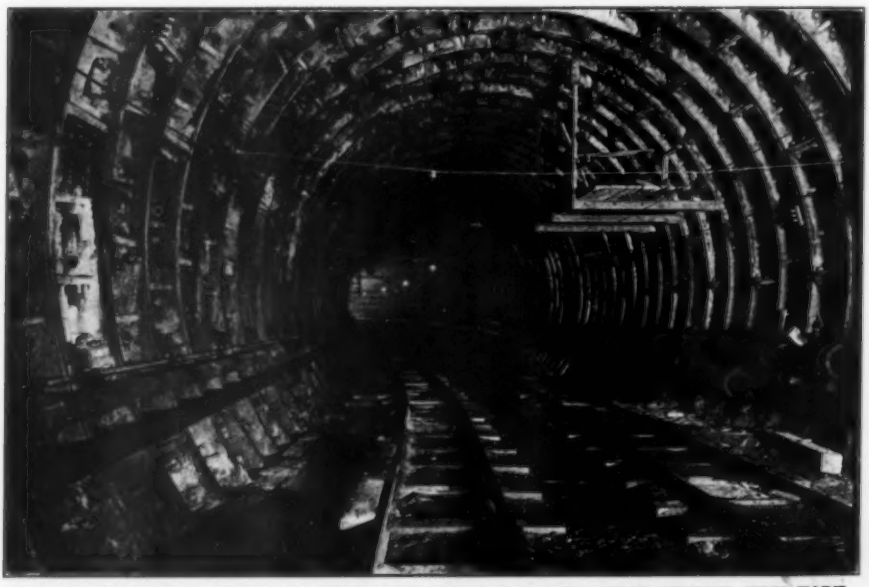
GROUTING IN THE SOUTH TUNNEL, NEW YORK

The illustration shows the Union grout machine and the men operating it and also the grout hose attached to a nipple in a segment of one of the rings



GENERAL INTERIOR VIEW OF THE NEW JERSEY POWER-HOUSE AT HENDERSON AND TWELFTH STREETS, JERSEY CITY

The power-plant consists of 7 low-pressure and 2 high-pressure Ingersoll-Rand compressors, 4 high-pressure Bethlehem and Dean hydraulic pumps, an hydraulic accumulator and electric switchboard. All air for the compressors is filtered through Mid-West air filters. The power-plant was erected and equipped by Booth and Flinn, Ltd., general contractors for the tunnel



A 1000-FOOT RADIUS CURVE IN THE SOUTH TUNNEL UNDER WEST STREET, NEW YORK

This picture gives a good idea of the size of the tunnel, which is 29 feet, 6 inches in diameter. The roadway level will be approximately at the elevation of the pipes shown along the sides of the tunnel. The platform at the right and separate hanging shelf for instruments are used when giving grades and lines for the tunnel

Building Conditions in the United States

Prepared by S. W. Straus & Company

East Shows Largest Gains

BUILDING permits issued in 311 cities during the first quarter of the present year were 8½ per cent ahead of the first quarter of 1923, which was about 49 per cent ahead of the first quarter of 1922. There was also an increase for March in the same cities of 3 per cent over March of last year, when the gain over March, 1922, was 60 per cent. While the March increase this year was not great by comparison with March, 1923, it must be remembered that March, 1923, was an abnormal month. Had March, 1924, merely equaled March of 1923, it would have still indicated a tremendous volume of pending construction.

It is significant, however, that Greater New York this year reported 36½ per cent of the total for the 311 cities in the first quarter and about 40 per cent of their total for March. The enormous gain in New York was due to the filing of building permits prior to April 1 to take advantage of the state tax exemption law on residential structures. With New York excluded, the gain over the first quarter of last year would be reduced to less than 3 per cent, and the month of March in the 311 comparable cities reporting would show a loss of 4 per cent instead of a gain of 3 per cent.

All the sections of the country, except the Central region, show gains in the first quarter; 92 cities in the East report a gain of 17 per cent; 45 Southern cities 4 per cent, and 76 Pacific Western cities 8 per cent. The loss for the quarter in the Central Region was 6 per cent. All regions, except the East, report a loss compared with last March: the Central, 3 per cent; the South, 5 per cent, and the West, 7 per cent. The March gain in the East, due to New York City's increase, was 9 per cent.

The twenty-five leading cities in volume of permits issued for the first quarter report about 72 per cent of the total for the 311 cities, showing that nearly three-quarters of the country's building program for the summer is contemplated in the larger cities.

SUMMARY OF FIRST QUARTER AND MARCH REPORT BY REGIONS

No. Cities	Regions	1st ¼ 1924	1st ¼ 1923	March, 1924	March, 1923	Gain or Loss ¼ '24-¼ '23	Gain or Loss March '24-March '23
92	East	$535,260,808	$457,771,453	$253,626,012	$232,891,484	$77,489,355 +17%	+$20,754,528
98	Central	221,229,579	235,823,621	103,715,996	107,372,474	14,594,042 —6%	—3,656,478
45	South	72,714,250	69,807,654	26,810,566	28,239,413	2,906,596 +4%	—1,428,847
76	West	130,460,509	120,759,049	46,354,671	49,977,127	9,701,460 +8%	—3,622,456
311		959,665,146	884,161,777	430,507,245	418,480,498	75,503,369 +8½%	+12,026,747

TWENTY-FIVE CITIES SHOWING LARGEST VOLUME OF PERMITS FOR FIRST QUARTER, 1924 WITH COMPARISONS

		First Quarter 1924	First Quarter 1923	March 1924	March 1923	March 1922
1.	New York	$352,098,028	$294,632,811	$171,948,746	$147,920,347	$105,608,892
2.	Chicago	59,524,420	76,695,447	26,712,900	30,371,447	19,333,900
3.	Los Angeles	46,521,696	44,534,914	17,279,758	21,196,087	10,964,829
4.	Detroit	36,084,613	30,366,455	17,704,688	16,809,235	4,935,392
5.	Philadelphia	31,572,970	34,368,745	16,756,560	21,064,085	9,210,510
6.	Cleveland	14,331,415	14,438,175	5,549,340	5,528,650	2,602,975
7.	Boston	14,096,041	9,640,442	5,614,321	4,707,238	4,665,500
8.	Rochester	13,578,873	3,528,701	1,123,888	2,134,266	1,304,346
9.	Baltimore	13,107,420	12,077,490	6,233,820	3,644,520	4,668,720
10.	San Francisco	11,743,511	9,714,059	4,652,933	3,229,572	3,289,251
11.	St. Louis	8,381,877	9,462,811	2,560,825	4,237,585	1,799,005
12.	Newark, N. J	8,282,502	6,938,324	3,843,783	2,679,603	3,053,125
13.	Milwaukee	8,218,538	4,919,241	5,079,081	2,234,454	1,843,261
14.	Dallas, Tex	7,888,622	6,619,832	2,712,158	2,059,537	1,593,007
15.	Seattle	7,710,625	4,500,333	2,151,860	1,362,985	1,791,670
16.	Pittsburgh	7,692,145	7,209,189	3,653,955	2,950,388	5,250,223
17.	Long Beach, Cal	7,641,420	6,402,929	2,287,240	1,974,618	1,154,083
18.	Portland, Ore	7,633,530	5,972,820	3,247,290	2,761,220	3,162,855
19.	Washington, D. C	7,500,471	13,044,079	3,231,677	3,781,038	3,236,647
20.	Oakland, Cal	7,166,152	6,475,948	2,896,416	2,581,989	1,925,577
21.	Buffalo	6,332,000	3,804,000	3,447,000	1,397,000	1,919,000
22.	Memphis	6,001,970	4,962,750	2,151,240	1,489,250	1,345,440
23.	Indianapolis	5,939,696	6,651,259	2,213,313	3,028,839	2,065,051
24.	Kansas City, Mo	5,166,150	6,661,201	2,337,700	2,999,650	1,263,050
25.	Denver	5,039,000	4,181,850	2,112,850	1,879,850	1,615,600
	Totals	$699,255,885	$627,803,805	$316,703,341	$294,023,453	$197,601,909

The Construction and Uses of Wire Rope

Helpful Suggestions and Information on Wire Rope and Cable

IRON rope is made in one standard grade. Steel rope is made in several grades of different tensile strengths in order to meet various requirements. Iron rope is soft and of low tensile strength, being composed of wire having a tensile strength of approximately 85,000 pounds per square inch. Cast steel rope is composed of wires having a tensile strength of from 160,000 to 200,000 pounds per square inch. Mild plow steel is slightly stronger than cast steel, having a tensile strength of from 190,000 to 220,000 pounds per square inch. Plow steel rope has a tensile strength of from 200,000 to 260,000 pounds per square inch. The highest grade of steel rope is composed of wires having a tensile strength of from 220,000 to 280,000 pounds per square inch. This wire is drawn from imported rods and is particularly strong, tough and durable.

Construction of Wire Rope

Wire rope is constructed by twisting together a given number of wires into a single strand and then twisting together a given number of these strands around a hemp core or center. This core acts as a cushion and is for the purpose of preserving a round shape to the finished wire rope. Occasionally, for certain purposes and under certain conditions, it is necessary to use a wire center instead of a hemp center.

The number of wires twisted together into a single strand and the number of finished strands twisted together around a hemp core vary according to the requirements for which the particular wire rope is intended. There are certain standard constructions into which wire rope is universally made, some one of which will usually meet the requirements necessary. These constructions are as follows:

Six strands, seven wires to each strand, known as 6 x 7; six strands, 19 wires to each strand, known as 6 x 19; six strands, 37 wires to each strand, known as 6 x 37; 8 strands, 19 wires to each strand, known as 8 x 19. In addition to these, the following constructions are also standard, but adaptable to ropes manufactured of only certain grades and used for certain purposes: 6 strands, each strand composed of 12 wires around a separate hemp center; 6 strands, each strand composed of 24 wires around a separate hemp center; 6 strands, each strand composed of 6 additional strands of 7 wires each, making 42 wires in each strand, with a separate hemp center in each of the additional strands.

The variation in the size of the wires used in the manufacture of a single strand or the variation of the lay of the wires in each single strand, or the variation of the lay of the strands in the rope, produces a various number of additional constructions. A rope consisting of 19 wires to the strand, for instance, may be made either with 1 center wire, surrounded by 6 additional wires and in turn surrounded by 12 additional wires, all of the same diameter, known as No. 1 construction; or 1 center wire, surrounded by 6 additional wires of the same diameter and in turn surrounded by 12 wires which are alternately large and small; this is known as No. 3 construction and is sometimes called "Warrington" construction. Or, 1 center wire surrounded by 9 wires of smaller diameter, which in turn are surrounded by 9 wires of larger diameter; this is known as "Seale patent" construction. Different operating conditions are best met by these different constructions.

By the "lay" of wire rope is meant the manner in which the wires or strands are laid or twisted together. This varies for different purposes. The standard construction of wire rope is to twist the wires in the strand toward the left and the strands in the rope toward the right. This is known as "right lay" rope, or "regular lay" rope. Sometimes, however, conditions require a "left lay" rope, in which case the wires in the strand are twisted toward the right and the strands in the rope are twisted toward the left. Occasionally, and for certain purposes, it is desirable to twist both the wires in the strand and the strand in the rope in the same direction. This is known as "Lang's lay" rope.

In point of flexibility, these different constructions might be graded as follows:

6 strands, 42 wires each, commonly called tiller rope
8 strands, 19 wires each, commonly called extra flexible hoisting rope
6 strands, 37 wires each, commonly called special flexible hoisting rope
6 strands, 19 wires each, commonly called hoisting rope
6 strands, 7 wires each, commonly called haulage rope.

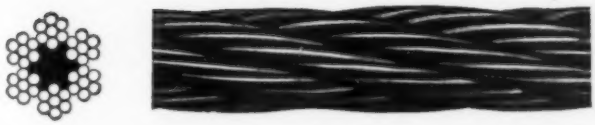
In point of strength, these constructions might be graded as follows:

6 strands of 7 wires each
6 strands of 19 wires each
6 strands of 37 wires each
8 strands of 19 wires each
6 strands of 42 wires each.

There is a very slight difference in the flexibility or strength of a hoisting rope when made No. 1 construction, No. 3 construction, or Seale patent construction. Rope made Lang's lay construction is more flexible than a regular lay rope, but is more easily untwisted and is more difficult to splice securely.

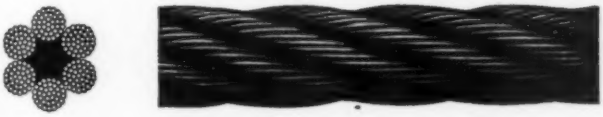
Selecting Wire Rope

Before determining what size, grade and construction of wire rope a contractor may re-



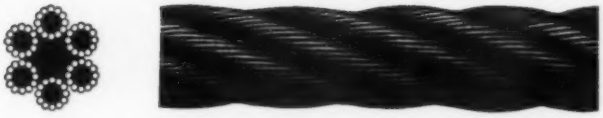
HAULAGE OR TRANSMISSION ROPE

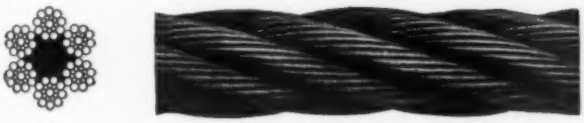
STANDARD HOISTING ROPE



SPECIAL FLEXIBLE HOISTING ROPE

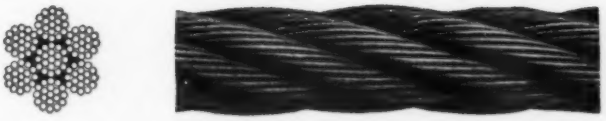
RUNNING ROPE AND TOWING HAWSERS

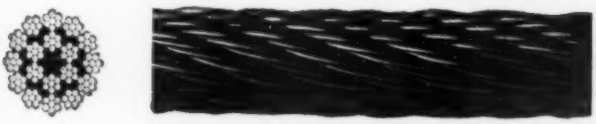




SEALE PATENT ROPE

WIRE CENTER ROPE





"KILINDO" PATENT NON-ROTATING WIRE ROPE

quire, he should study his conditions thoroughly. The best results are secured only by obtaining the most suitable rope to meet the individual conditions, and if at all undecided, the contractor should submit a sketch of the rope conditions to a manufacturer and give the following information: greatest load, average load, speed of rope, size of drums and sheaves, if for use on an incline or haulage, the elevation in feet, and the greatest degree of incline at any given point.

It is always much better to hold the rope speed down as much as possible, as, for instance, increasing the load and decreasing the speed of the rope is much preferable to decreasing the load and increasing the rope speed. High speed tends to crystallize wires and causes them to crack and break much sooner than a heavier load with slower speed.

When conditions permit only of the use of small sheaves, and a heavy load is necessary, it is often advisable to use a rope of high tensile strength and small diameter rather than a rope of large diameter and equal tensile strength. It is imperative also in selecting a wire rope to see that the sheaves and drum over which the rope is to work are grooved to fit the rope. If it is attempted to use a ¾-inch rope over a sheave grooved only for a ⅝-inch rope, the rope will pinch in the sheave and show wear very quickly.

Rope for Specific Uses

Haulage or transmission rope is composed of 6 strands of 7 wires each, laid around a hemp center, making a total of 42 wires. This rope is made in iron and all grades of steel to suit different working conditions. The rope should never be operated over small drums or sheaves, the wires being too coarse.

Standard hoisting rope is composed of 6 strands of 19 wires each, laid around a hemp center, making a total of 114 wires. This rope is made in iron and all grades of steel. It is the most commonly used rope for hoisting purposes, and where sheaves are built to accommodate it, it is the most practical rope to use.

Special flexible hoisting rope is composed of 6 strands of 37 wires each, laid around a hemp center, making a total of 222 wires. Where extra flexibility is required on account of small sheaves or drums, this rope is recommended.

Extra flexible hoisting rope is composed of 8 strands of 19 wires each, laid around a hemp center, making a total of 152 wires. This rope is used where the drum and sheaves are small in comparison to the size of the rope. It is about as flexible as the 6 x 37 construction, but because of the larger hemp center, it is not so strong.

Tiller rope or hand rope is composed of 6 independent wire ropes laid around a hemp center, making a rope of 252 wires with 7 hemp centers. It is the most flexible wire rope made, but, being composed of very fine wires, it will not stand much frictional or surface wear, and the load should be light.

Running rope and towing hawsers are composed of 6 strands, each strand composed of 12 wires laid around a separate hemp center, making a total of 72 wires with 7 hemp centers. In external appearance this rope resembles the 6 x 19 construction, but is only about two-thirds as strong.

Hawser and mooring lines are composed of 6 strands, each strand composed of 24 wires laid around a separate hemp center, making a total of 144 wires with 7 hemp centers. These are commonly called English hawsers.

Deep-sea towing hawsers are composed of six strands, each strand composed of 37 wires, making a total of 222 wires and one hemp center.

Seale patent rope is composed of 6 strands of 19 wires, each laid around a hemp center. Each strand is composed of one large center wire surrounded by 9 smaller wires, which in turn are surrounded by 9 larger wires. This construction produces a rope almost as flexible as standard hoisting rope, but of greater durability in any service where the rope is exposed to unusual abrasion.

Wire center rope is made for use under certain conditions where hemp centers canot be used to advantage, such as in suspension bridge cables, main cables for cableways, track cables, or where rope is exposed to excessive heat, which soon dries out and burns a hemp center.

Galvanized iron or crucible steel ship or yacht rigging and guy ropes are composed of 6 strands of either 7 or 12 wires each, laid around a hemp center.

Flexible galvanized crucible steel yacht rope is composed of 6 strands of 19 wires each, laid around a hemp center.

Right and Left Lay Rope

Wire rope is usually made right lay as standard. The use of left lay rope is usually confined to conditions where rope is used in pairs, using both a right lay and a left lay rope. Thus the natural tendency of one rope to untwist is offset by the other. Left lay rope is frequently used for drilling wells, such as for oil or gas.

In regular lay rope the wires in the strand are twisted in one direction and the strands are twisted in the opposite direction. In Lang's lay rope the wires in the strands and the strands in the rope are twisted in the same direction. This construction produces a greater wearing surface on each individual wire and tends to resist the wear from friction or dragging over rollers on the ground, but this construction will much more easily untwist or kink than the regular lay and it is much more difficult to splice securely.

Non-Rotating Wire Rope

A patented non-rotating wire rope, known as Kilindo, is made by the Macwhyte Company, Kenosha, Wis., manufacturers of all kinds of wire rope, using 18 strands of 7 wires each, 6 inner strands twisted to the left and 12 outer strands twisted to the right. This results in a rope which it is claimed will not spin or twist in use.

Helpful Catalogs

The catalogs and pamphlets listed below are available for free distribution. Contractors and Engineers who check over these pages each month and write for such material as interests them, will find this a valuable means of keeping up to date on the subject of machinery and equipment.

PROFITS FOR ROAD CONTRACTORS

The latest literature of the Blaw-Knox Co., 667 Farmers Bank Bldg., Pittsburgh, Pa., describes Blaw-Knox road and street forms, Batcherplants, turntables and steel bins, which give a road contractor maximum efficiency and which are said to be used by the majority of highway contractors.

TRACTORS FOR RUSH JOBS

If you have rush work ahead of you this spring, it will be well to investigate Best "Thirties" and "Sixties," which are able to handle heavy work, involving hauling blade graders, elevating graders, wheel scrapers and other road and grading machinery. Complete information may be secured from the C. L. Best Tractor Co., San Leandro, Calif.

HOT MIX IN SIX MINUTES

The new Iroquois rapid mixers that are described in the literature of the Barber Asphalt Co., Land Title Bldg., Philadelphia, Pa., require only six minutes to turn out a 4-cubic-foot mixture of asphalt and need only two men to operate them. This enables contractors and street departments to do small bituminous repair jobs easily, quickly and at a surprisingly low cost.

ELECTRICALLY WELDED FABRIC

Clinton electrically welded fabric for concrete reinforcement made from low carbon drawn steel wire, the mesh being formed with clean-cut rigid connections obtained by electrically cross-welding the longitudinal and transverse wires, is furnished in various sizes of wire and mesh in rolls, or sheets, and is described in detail in the literature of the Wickwire Spencer Steel Corp., 41 E. 42nd St., New York City.

BUILD BETTER CONCRETE ROADS

A practical handbook on concrete road construction containing 54 pages and discussing the reinforcing of concrete roads, wire mesh, doweled contraction joints, the properties of rib bars, curb bars, describing reinforced concrete bridges and giving tables, of sizes, areas, weights and gages, as well as quantities of materials for various concrete mixtures, may be secured free by any interested contractor from the Truscon Steel Co., Youngstown, Ohio.

DEPENDABLE TRENCH PUMPS

Contractors are finding more uses every day for gasoline-engine-driven pumps, hoists and portable air compressors. If you are interested in a time-, money- and labor-saving piece of machinery for your work, send for descriptive Bulletin C, issued by the Domestic Engine & Pump Co., Shippensburg, Pa.

MIXERS FOR BETTER BUILDING WORK

Contractors will do well to prepare for the continuation of building on an even greater scale than in 1923. Send for a copy of the Jaeger catalog describing a complete line of tilting drum mixers, including 24 outfits. This catalog may be secured from the Jaeger Machine Co., 701 Dublin Ave., Columbus, Ohio.

EXPLOSIVES AND CIVILIZATION

In a particularly interesting book, "Conquering the Earth," which may be secured free by any readers of **Contractors' & Engineers' Monthly**, from the Advertising Dept., Hercules Powder Co., Wilmington, Del., will be found an elaboration of the events in the conquering of the earth through the ages from stone hatchets to dynamite.

REPAIR BLADES FOR SCRAPERS AND DRAGS

The 1924 Price List No. 17 issued by the Shunk Mfg. Co., Bucyrus, Ohio, gives some interesting facts regarding the high-grade blades and cutting edges which this company manufactures and maintains in stock for the repair of all kinds of road scrapers, road drags, and slip scrapers. The line also includes new scarifier teeth.

FEWER MEN IN THE GRADING GANG

It is not necessary to have a big gang on a grading job. Two or three men can handle a Baker-Maney train of three to six scrapers with an output of 500 to 600 cubic yards a day with low up-keep and low operating cost. Literature and price lists on Baker-Maney scrapers will be furnished promptly by the Baker Mfg. Co., 585 Stanford Ave., Springfield, Ill.

CAST IRON PIPE WITH UNIVERSAL JOINTS

The flexibility and tightness of the machined joint of Universal pipe and the reason why it is a favorite for water-supply and fire protection systems, sewage disposal, gas lines, subaqueous lines and for other service where freedom from leakage is essential, is told in the literature of the Central Foundry Co., 41 E. 42nd St., New York City.

WATER-WORKS SPECIALTIES

Catalog No. 20, which is issued by the H. W. Clark Co., Mattoon, Ill., describes the complete line of Clark water-works specialties, including valve boxes, pipe pushers, service boxes, valve housings, pipe jointers, pipe cutters, etc.

TRUSTWORTHY ENGINES FOR CONTRACTORS' OUTFITS

The Climax Engineering Co., 1 W. 18th Ave., Clinton, Iowa, will be glad to send its catalogs describing Climax, "The Trustworthy Engine" which has been adopted by a number of manufacturers as standard equipment for contractors' machinery.

DRILLING CONCRETE

Bulletins 1043, 1044 and 1045 issued by The Dallett Co., 165-189 W. Clearfield St., Philadelphia, Pa., describe the complete Dallett line of hand tools for concrete drilling, including the Baby plugger for drilling holes and cutting ducts in concrete, and the concrete busher for bushing concrete surfaces.

DEPENDABLE TRACTORS

In the descriptive literature of Monarch Tractors, Inc., Watertown, Wis., are discussed the three models of Monarch industrial tractors, which the manufacturers claim have proved their dependability, assuring contractors that degree of service and satisfaction so necessary to profitable performance.

MORE POWER FOR THE FORD

The Warford selective type transmission for Ford cars and trucks gives more power to these machines for road service. Complete information regarding this auxiliary may be secured from the Warford Corp., 44 Whitehall St., New York City.

ROAD PLANERS, GRADERS AND DRAGS

A complete line of road planers, graders and drags which have shown their value in road work in many parts of the country, will be found described and illustrated in the literature of N. S. Monroe & Son, Manufacturers, Arthur, Ill.

A COMPLETE LINE OF METERS

The latest illustrated catalog of the Neptune Meter Co., 50 East 42nd St., New York City, describes every type of meter for domestic and industrial service and for the metering of fire lines. This literature will be sent free on request.

LETTERING GUIDES FOR ENGINEERS

Wrico lettering guides and lettering pens, which make it possible for inexperienced draftsmen to letter quickly, neatly and uniformly, are described in the literature of the Wood-Regan Instrument Co., Inc., 154 Nassau St., New York City.

TRACTION MOUNTING FOR RAILROAD TYPE SHOVELS

The Bucyrus Co., South Milwaukee, Wis., has just issued a new Bulletin, M-10, describing its traction mounting for railroad type shovels. These mountings are available for steam, gasoline and electrically operated shovels.

BELT CONVEYORS FOR MATERIAL HANDLING

A new catalog, No. 25, has recently been published by the Atlas Engineering Co., Milwaukee, Wis., illustrating its Red Head portable conveyor as well as other types of Atlas belt conveyors.

RIVET SETS AND CHISEL BLANKS

The Steelcraft Parts Co., 203 E. 15th St., New York City, has issued a booklet and a folder describing its complete line of rivet sets, pistons for riveting hammers and chipping hammers, chisel blanks, punch dies, punches and light forgings, all used to a large extent in contracting work.

PLANT EQUIPMENT SPECIALS

Bulletin No. 315 issued by the Walter A. Zelnicker Supply Co., 511 Locust St., St. Louis, Mo., lists a large quantity of locomotives, ballast cars, industrial cars, piling, tanks and cranes, of interest to contractors all over the country.

RESURFACING BLOCK TYPE PAVEMENTS

The method of resurfacing worn brick and block pavements with asphalt is very clearly and simply presented in a booklet issued by the Asphalt Sales Dept., The Texas Co., 17 Battery Pl., New York City. The booklet contains photographs and cross-sections which assist in describing the method involved.

LAYING ROCK ASPHALT

Brochure CEM issued by the Kentucky Rock Asphalt Co., Inc., 711-718 Marion E. Taylor Building, Louisville, Ky., tells contractors how they can lay Kyrock, a natural rock asphalt, to make a practical sheet asphalt pavement at a remarkably low figure.

ON-THE-JOB PHOTOGRAPHS

The new P & H Bulletin 80-X, issued by Pawling & Harnischfeger Co., 3819 National Ave., Milwaukee, Wis., shows 36 pages of P & H equipment on the job and gives data and specifications of particular interest to contractors who are facing grading and excavating jobs.

WHAT KIND OF EXPANSION JOINT?

The Philip Carey Co., 9 Wayne Ave., Lockland, Cincinnati, Ohio, manufacturers of Elastite expansion joints, an elastic resilient material, composed of two sheets of asphalt-saturated felt, between which is sandwiched a body of refined asphaltic compound, will be pleased to send literature to any contractors interested, showing the ease with which this type of expansion joint may be installed in concrete roads, buildings, bridges and other structures.

MOTOR TRUCKS THAT MEET DEMANDS

Surplus strength and power with high road speed and an ability to stand up under the stress of heavy daily service are requisites of GMC trucks, which are described in a free booklet, "Seven Steps Ahead," that may be secured from Dept. 7, General Motors Truck Co., Pontiac, Mich., free on request.

TANDEM PAVING ROLLERS

The Erie Machine Shops, Erie, Pa., have literature which tells how their claim of making the best tandem road roller on the market has been substantiated in the service which these rollers have been giving since 1887.

DO YOU TEST YOUR METERS?

Every city water department or company should regularly take its meters from service and test them to be sure that they are registering accurately. The Ford Meter Box Co., Wabash, Ind., makes an inexpensive testing machine which is described in detail in literature which may be secured free on request.

ROAD MACHINERY OF ALL KINDS

The Galion line of road machinery, including steam and motor macadam rollers, steam and motor tandem rollers, road graders, car unloaders, stone and gravel spreaders, gravel-screening plants, small tools and culvert pipes, is described in the illustrated literature of the Galion Iron Works & Mfg. Co., Galion, Ohio.

DEPENDABLE ROAD TOOLS

One-man-maintainers, 4-cylinder gasoline road rollers and steam road rollers are among the Huber road tools described in the literature of the Huber Mfg. Co., Marion, Ohio.

GATE-VALVES AND FIRE-HYDRANTS

Ludlow gate-valves for water, steam, gas, or oil, either hydraulically or electrically operated, in all styles and sizes and for any pressures, as well as Ludlow frost-proof fire-hydrants, are described in the illustrated catalog of the Ludlow Valve Mfg. Co., Troy, N. Y.

DO YOU BID CLOSE ON ROCK EXCAVATION?

The catalog of the Denver Rock Drill Mfg. Co., Denver, Colo., describing Waugh rock drills, tells you why it is possible to bid closer on rock excavation jobs when you standardize on Waugh drills, sharpeners, hoists and portable compressors.

LONG-LIVED PAINT FOR METAL WORK

The Joseph Dixon Crucible Co., Jersey City, N. J., in its booklet No. 107-D, describes in detail the composition and uses of Dixon silica graphite paint, which, it is claimed, will put off the necessity of repainting for the longest period of time, and lower your cost of paint up-keep.

ONE MAN CAN CURE CONCRETE ROADS

The booklet, "How to Cure Concrete," issued by the Dow Chemical Co., Midland, Mich., tells how one man with the use of a light hand truck and Dow distributor in a couple of hours can cure all of the concrete which a mixer can lay in a day.

ASPHALT PLANTS FOR QUICK DELIVERY

The East Iron and Machine Co., Lima, Ohio, will be glad to send descriptions of its 1,200-yard and 2,000-yard Merriman asphalt plants, which have just been rebuilt and put into fine condition and are ready for quick shipment for contractors' spring work.

AN IMPROVED ASPHALT SURFACE HEATER

A surface heater which is used to resurface old asphalt pavements and one of which has restored 150,000 yards annually in New York City, saving approximately $150,000, is described in detail in the catalog of the Equitable Asphalt Maintenance Co., Kansas City, Mo.

BULLETINS ON WATER-METERS

The Badger meter, which has proved its dependability, accuracy and earning powers, and which is claimed to be "faithful to the last drop," is described in the literature of the Badger Meter Mfg. Co., 841 30th St., Milwaukee, Wis.

A New ¾-Yard Diesel Engine Shovel and Dragline

TO still further broaden its field of excavating machinery, the Bucyrus Company, South Milwaukee, Wis., has recently put on the market a ¾-yard shovel and dragline operated by a full-diesel engine. This machine is a small edition of the 30-B 1-yard diesel machine which was announced about 18 months ago. The outstanding feature of the machine is the fuel economy due to the use of low-grade fuel oil of high heat value. The cost of this oil varies considerably, but in general it is between one-third and one-quarter that of gasoline. Based on past experience with the 1-yard machine, it is claimed that the new 20-B machine will consume about 1½ to 2 gallons of fuel oil per hour, depending upon the type of work.

A BUCYRUS 20-B DIESEL-ENGINE DRAGLINE AT WORK CHANGING THE COURSE OF A CREEK FOR THE CITY OF SOUTH MILWAUKEE, WIS.

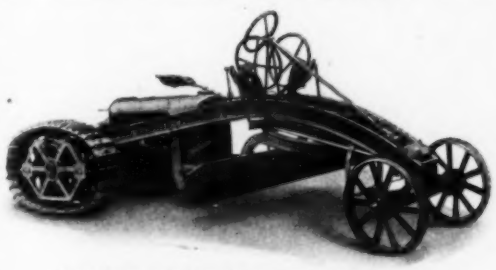
The outstanding simplicity of the machine is said to have caused considerable comment. It is a rope-thrust machine, that is, instead of being equipped with an independent engine or motor on the boom or a complicated thrusting device, all of the motions of the dipper are controlled by a small drum mounted under the boom, which is turned in either direction by ropes from the main machinery. The dipper is as easily controlled as a steam machine, and in addition has a greater thrust with all the force of the main engine behind it.

The engine is a 45-horse-power mechanical injection 3-cylinder engine, built especially for this service. The 20-B may be equipped as a shovel with standard, high-lift or extra high-lift boom, or as a dragline excavator, a clam-shell excavator with a 35- or a 42-foot boom, or with crane equipment.

A One-Man Grader That Cuts Costs

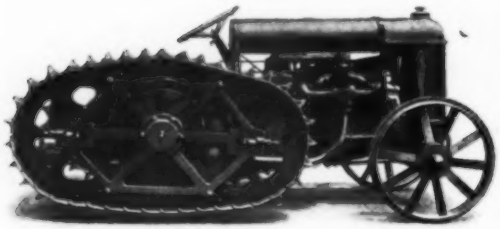
Manufacturers Claim This Machine Does the Work of Two Horse-drawn Graders at Less Cost

A ONE-MAN grader that makes use of the remarkable power-plant of the Fordson tractor aided by H.-P. rigid rail tracks on the tractor has been put on the market by the Hadfield-Penfield Steel Company, Bucyrus, Ohio. The design of this grader increases the power of the Fordson and puts the entire weight on the cutting blades, giving the grader an increased range of dependable usefulness.



GRADER ATTACHED TO TRACTOR

The one-man grader is adaptable to grading, ditching and patrol work and will operate on the level or at a decided angle. It is adaptable also to the removal of snow and makes a dependable, one-man patrol outfit. The manufacturers claim that it will do two-thirds more work than a horse-drawn grader, and will grade a mile of road at 18 per cent of the cost of a horse-drawn job. The grader can be attached to a Fordson in one hour without the use of any extra parts.



TRACTOR EQUIPPED WITH TRACKS TO INCREASE HAULING EFFICIENCY

The motor is controlled by the governor of the tractor, allowing the operator to give his entire attention to the grading job. The gear-shift and clutch levers can be operated with equal ease from the seat of the platform, so that no skilled operator is required.

Where the grader is used for the maintenance of hard gravel or stone roads or for city or municipal work, rubber wheels are used, which gives the unit the speed required for traveling from place to place, and ample traction for that class of work. When the grader is used in heavy road grading as in the construction of new roads or subdivisions, standard wheels may be used, or for greater traction H.-P. rigid rail tracks are used. For heavy snow removal, rigid rail tracks give increased efficiency for the entire outfit.

This single-unit tractor grader is well adapted to contracting work, as in doing finished grading the 13½-foot wheel-base gives a remarkable leveling effect, the blade being rigidly carried between the four wheels, thus permitting the grade to be kept to a fraction of an inch. In working between the forms, the grader keeps the road level.

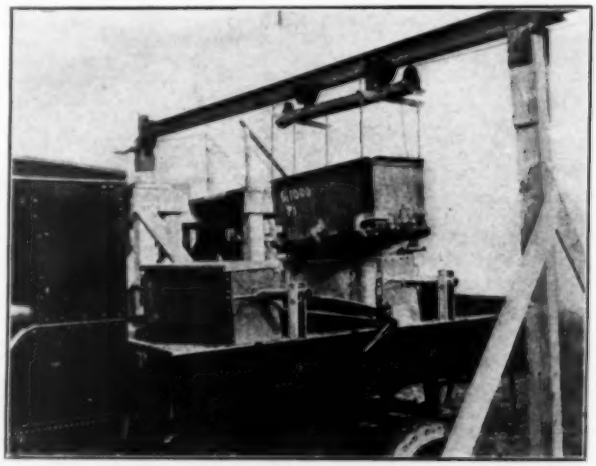
Mechanical Handling of Cement on Road Jobs

New Loading Device and Carriers Reduce Labor Needed at Mixer

ON road jobs 3 to 5 men are usually needed to load cement into the paver. They open up the bags of cement after the sand and stone are deposited in the skip of the mixer, and throw the cement on the material. This operation not only uses several laborers, but sometimes delays the loading of the mixer itself. To eliminate this extra labor, a cement-handling system has been developed by the Blaw-Knox Company, Pittsburgh, Pa., consisting of a fast-acting cement charger or hopper which operates between the cement shed and the truck carrying the batches and aggregate to the mixer.

The cement charger, with a four-leaf drop-bottom door, runs on an I-beam trolley extending from the shed and spanning the truck runway. The charger is loaded in the shed and runs by gravity to the required position directly over the truck compartment. It permits uniform employment of time on the part of the laborers at the cement shed who fill the cement chargers during the intervals between the arrival of trucks, and also greatly reduces the length of time the truck is stopped for loading. Ordinarily, when a cement truck is loaded, a bull gang of 5 to 10 men will work feverishly in order to load the truck so as not to delay the work, and when the truck is gone they hang around with nothing to do until the next truck arrives.

The second part of the Blaw-Knox cement-handling system is a steel cement container or box of special construction which is placed and hinged on adjustable standards affixed to the side of a truck body. With two or three or more of these cement containers on a truck, the truck body can be elevated and one material compartment released, opening a drop-bottom door automatically and chuting the cement into the skip with the sand and stone.



CEMENT-HANDLING BOX DELIVERING BULK CEMENT TO CARRIERS MOUNTED ON MOTOR TRUCK

Recommended Minimum Requirements for Masonry Wall Construction---Part II

PART III

APPENDIX

Par. 1. Purpose

The Appendix consists of explanatory matter referring to Part II and is a vital part of this report. The Committee believes that every building code should be accompanied by an Appendix which should contain sufficient explanation of the code requirements to make them easily understandable and such other information on good practice as cannot be obtained elsewhere in concise form. It is recommended in the event of any state or municipality using Part II as a basis for a building ordinance that an appendix similar to that herewith be published with the ordinance for the direct benefit of builders.

Par. 2. Function of Walls

Under prevailing interpretations of the police power there are certain definite requirements which masonry walls in building must meet:

1. They must not fail structurally under loads or conditions incidental to the building's occupancy.
2. They must resist moisture penetration to an extent unfavorably affecting living or working conditions, or the integrity of the wall itself.
3. Under fire exposure their stability must be such as to afford reasonable safety to firemen, and they must discharge the functions of support and heat insulation necessary for avoidance of undue fire loss. (See footnote.)

Par. 3. Variation in Code Requirements

So far as can be determined from an examination of present code practice, experience in satisfying these requirements has not resulted in uniform practice. The Committee had reference to three independent investigations.

1. An analysis by the Bureau of Standards of the requirements of 134 building codes, representing all parts of the country, disclosed the following facts:

68 ordinances specify minimum allowable thicknesses for brick panel walls:

Of these, 18 call for 8-inch thickness, and
30 call for 12- or 13-inch thickness in such walls.

33 codes specify thicknesses for tile panel walls as follows:

14 require 8-inch thickness, and
19 call for 12- or 13-inch thickness.

In 39 cases specific requirements for thickness of reinforced concrete panel walls are given, namely:

2 call for 4-inch thickness,
4 call for 6-inch thickness,
16 call for 8-inch thickness,
10 call for 12-inch thickness,
2 call for 13-inch thickness.

Only 1 code specifically mentions the use of concrete units as proper materials for panel walls, the thickness required being 12 inches.

14 codes make no difference between the various masonry materials, merely stating the thickness.

Of these, 6 call for an 8-inch wall, and
8 call for a 12-inch wall.

2 codes forbid such walls to be thinner than 1/16th or 1/20th of their height between horizontal supports.

1 code specifies that panel walls shall not be longer than 20 feet between vertical supports.

9 codes limit the height between horizontal supports, requiring that the thickness be increased if the limits are exceeded. These limits vary between 10 and 20 feet. In some cases they apply to specific materials only and in other cases their application apparently is general.

10 codes limit both height and length of panel walls supported at each story, the limits varying from 12 x 12 feet to 14 x 30 feet. In most cases the larger limits are for the thinnest walls.

2 codes regulate thickness on basis of square feet of wall surface.

3 codes require party walls to be 4 inches thicker than exterior walls.

3 codes permit use of metal lath and plaster or of Gunite for panel walls under limited conditions of exposure.

The average of the thicknesses specified in the 84 codes examined is 10.86 inches for brick, 10 inches for tile, and 8.57 inches for reinforced concrete.

2. An analysis of requirements regarding necessary thickness of brick bearing walls for 8-story structures in 20 codes chosen at random, disclosed 18 different sets of requirements, and doubtless further investigation would have discovered additional ones. These variations, furthermore, bore no relation to requirements for other matters which might affect the wall thickness.

Variation such as illustrated above, arises from the facts that standards of performance are unequal; that exposures and allowable working stresses vary; and that materials and workmanship differ widely in different localities. In theory at least, minimum standards of performance should be uniform, irrespective of location and other conditions, except perhaps those

AVERAGE REQUIREMENTS OF 134 CODES FOR BRICK FOUNDATIONS AND SOLID EXTERIOR WALLS FOR DWELLINGS

Thickness Within Fire Limits Only

Foundation in Inches	Stories: First Inches	Second Inches	Third Inches	Fourth Inches	Height Feet	Length Feet	Width Feet	Area Sq. Ft.
12.5	9.7	...	...	...	15.5	65.9	23.7	1,311
13.7	11.0	9.7	...	...	28.7	69.8	24.3	1,311
16.2	13.1	11.8	10.5	...	41.5	80.2	24.4	....
18.5	16.0	13.5	12.3	11.2	53.7	80.6	24.9	....
			Thickness Within or Outside of Fire Limits					
12.5	9.2	...	...	...	15.3	65.7	23.5	1,244
13.6	10.4	9.2	...	...	28.5	69.7	23.9	1,404
16.2	12.8	11.5	10.2	...	41.5	81.8	22.9	....
18.5	14.4	13.2	12.0	11.0	54.0	83.6	25.0	....

Among the 134 codes there were three different minimum thicknesses prescribed for one-story residential buildings, four for two-story dwellings, eight for three-story dwellings, and no less than twelve different thickness arrangements for those of four stories. Other conditions being equal, the thickest four-story wall contained 125 per cent more brick than the thinnest. A similar situation was found to exist in regard to walls of clay hollow building tile and hollow concrete block.

2. An investigation was made by the Committee of code requirements for panel or enclosure walls supported at each story, with the following results:

Of 84 municipal building codes examined, 30 do not distinguish between panel walls supported at every story, and bearing or non-bearing walls not thus supported.

6 codes recognize panel walls as a separate class but require that their thickness for the lower stories be increased with the height of the building.

FOOTNOTE.—The protection of stored commodities or prevention of interior deterioration is also an important function of walls and should be considered. It does not come within the police power.

due to climate.

Part II of this report presents all the requirements which the Building Code Committee considers essential to meet such uniform standards of performance and states these recommended requirements in the minimum terms considered necessary for protection of the public health and safety.

Par. 4. Walls Supported at Each Story

In skeleton construction that portion of a panel wall between window sill and floor is sometimes called an apron wall. Similarly, that portion of a panel wall between the top of the windows and the floor above is occasionally designated as a spandrel wall.

In view of some confusion which occurs in use of the terms "curtain wall" and "panel wall" their definition in the code is considered desirable.

Par. 5. Division Walls

In fire-resistive buildings having floors and roof meeting the requirements of the four-hour standard fire test, a division wall with offsets in one or more stories, but forming with the floors a complete separation of two portions of a building throughout, and projecting through the roof as a parapet, or incorporated with the roof and without parapet, will serve the purpose of a fire-wall, provided that it conforms to the thickness requirements of a fire-wall.

Par. 6. Masonry, as Distinguished from Concrete

Strictly speaking, the term "masonry" is limited to the use of stone units. In the trades a mason is a workman who deals with stone work only. A mason, which also implies stone cutter, is a higher grade of mechanic than a bricklayer who builds with brick and tile. These terms, together with that of "plasterer," have come down to us from the ancient guilds and are still preserved in the trade unions. Where used in this report, the expression "masonry walls" does not include plain or reinforced concrete walls or those of grouted construction.

Par. 7. Quality of Brick

Brick: The Building Code Committee has tentatively adopted the Standard Specification of the American Society for Testing Materials for medium grade as a basis for a minimum requirement for clay and sand-lime building brick. On account of practical enforcement difficulties no provision has been made in the recommendations for recognition of several grades of building brick as described in the Standard Specifications. Where it is established to the satisfaction of those in authority that the quality of brick available for load-bearing masonry is uniformly better than the medium grade described by the American Society for Testing Materials standard, it is recommended that proportionate increases be allowed in the unit working stresses as recommended in Part II.

Careful provision should be made for utilization of masonry building materials which may hereafter be developed, by regulating their use on a performance basis similar to that which underlies the requirements of Part II for those already well known.

The Standard Specifications of the American Society for Testing Materials for Clay Building Brick are as shown below.

The standard specifications of the American Society for Testing Materials are the result of long and thorough investigation, and represent the agreement of manufacturers and producers as to the standards of quality necessary for practical, successful results. They are intended for incorporation in working agreements of all sorts and under any conditions, and are therefore especially to be recommended for the general purposes of building codes.

Specifications for concrete brick are under consideration both by the American Concrete Institute and the American Society for Testing Materials. The Building Code Committee has proposed the code requirements in Part II, Section 2, with the hope that the opportunity for discussion thus provided will bring the matter fully up to date before publication of its final report.

Par. 8. Mortar Materials

The influence of small proportions of clay and loam on strength of mortar is so irregular that it was felt unwise to set a permissible limit on their presence. The requirement that sand be clean permits exaction of a high standard where considered necessary by the authorities and makes for ease of enforcement under practical working conditions.

No requirement for mixing water was included, as recent extensive investigations have shown that the kinds and amounts of material carried in solution or suspension in water from even the most doubtful sources have no particular effect on the strength of concrete. The same is assumed to be true of mortar.

Par. 9. Tests of Compressive Strength of Brick Masonry

In recommending limits of working stresses for brick masonry, the Committee had reference to a large number of test series, which are listed following. These series of tests included in all 541 piers and 39 short walls:

1. Tests of 33 brick piers at the Watertown Arsenal in 1884, under supervision of J. E. Howard
2. Tests of 48 brick piers at Watertown Arsenal, in 1886, under supervision of J. E. Howard
3. Tests of 8 brick piers at University of Toronto under supervision of Prof. E. Gillespie in interest of Toronto Building Department
4. Tests of 50 brick piers at Bureau of Standards Laboratory, Pittsburgh, Pa., in 1917, under supervision of J. G. Bragg
5. Tests of 6 brick piers with special reinforced joints at Cornell University, in 1900, under supervision of Prof. E. J. McCaustland
6. Tests of 27 brick piers at Columbia University, under supervision of Prof. James S. Macgregor, reported under date of 1916
7. Tests of 54 brick piers made at Technical High School in Stockholm, some time previous to 1917, under direction of Prof. H. Kreuger
8. Tests of 26 brick piers at Watertown Arsenal in 1904, under supervision of J. E. Howard
9. Tests of 13 brick piers at Watertown Arsenal in 1905, under supervision of J. E. Howard
10. Tests of 15 brick piers at Watertown Arsenal in 1906, under supervision of J. E. Howard
11. Tests of 32 brick piers at Watertown Arsenal in 1907, under supervision of J. E. Howard
12. Tests of 16 brick piers at Laboratory of School of Practical Science 1895-6, under supervision of J. Keele
13. Tests of 57 brick piers conducted under supervision of Committee of Royal Institute of British Architects, reported in a publication under date of 1905
14. Tests of 16 brick piers at University of Illinois Engineering Experiment Station in 1907, by Arthur N. Talbot and Duff A. Abrams
15. Tests of 4 brick piers cut from masonry of wrecked building, 16 years old, in New York City, made at Columbia University in 1922 under supervision of R. P. Miller
16. Tests of 135 clay, sand-lime and concrete brick piers at Columbia University in 1921 and 1922 under supervision of A. H. Beyer and W. J. Krefeld
17. Tests of 6 thin brick walls in 1920 by Dr. Oscar Faber in interests of British Government
18. Tests of 33 brick walls at Bureau of Standards Laboratory in Pittsburgh in 1920 and 1921, under supervision of Dr. A. H. Stang

The widely different circumstances under which these piers were built and tested preclude a general summary or average of results in arriving at unit working stresses for masonry. Nevertheless, it is possible, by segregating groups of experiments, alike except in one particular, to trace with some certainty

Grade	Absorption Limits, Per Cent: Mean of Five Tests	Absorption Limits, Per Cent: Individual Maximum	Compressive Strength (on Edge) Pounds per Square Inch: Mean of Five Tests	Compressive Strength (on Edge) Pounds per Square Inch: Individual Minimum	Modulus of Rupture, Pounds per Square Inch: Mean of Five Tests	Modulus of Rupture, Pounds per Square Inch: Individual Minimum
Vitrified brick	5 or less	6	5,000 or over	4,000	1,200 or over	600
Hard brick	5-12	15	3,500 or over	2,500	600 or over	400
Medium brick	12-20	24	2,000 or over	1,500	450 or over	300
Soft brick	20 or over	No limit	1,000 or over	800	300 or over	200

the effects of various conditions on compressive strength, and to arrive logically at factors of safety and working stresses.

Par. 10. *Lateral Support of Walls*

The story height or the unstayed height is recognized as having a very important effect on the stability of walls. Experimental data bearing on the safe limits is insufficient for conclusions, but a wide survey of results in practice indicates that the slenderness ratio of 20 adopted in Part II, Section 3, is the maximum reasonably consistent with the thickness requirements adopted. Consideration was given to the use of stories as units of wall height, but in view of the wide variation in story heights employed in different parts of the country, the Committee feels this method of stating minimum requirements is not sufficiently definite. The permissible spacing of supports, however, is thought to be such as will allow of economical utilization of wall height in any region.

Lateral Support: Regarding the nature and necessary frequency of lateral support, matters commonly specified in building codes, the expression of opinion obtained by the Committee was not conclusive. In building for residential purposes, it appears that the support afforded by closely spaced partitions and floors makes buttresses or pilasters unnecessary. In buildings for commercial or industrial purposes, the heavier floor construction and loading assists in giving the necessary stability. The spacing of supports prescribed in Part II is varied in recognition of the superior stability resulting from rigid floors and interior framework. In general, a 4-inch increase in wall thickness is not considered adequate as a substitute for the reinforcement methods prescribed in Part II. It is strongly recommended where exposures are extreme or high winds prevail, that long bearing walls be broken as often as possible by angles or cross-walls, and that chimneys, elevators and stair-shafts be so placed as to reinforce such long walls whenever possible.

Par. 11. *Elements Affecting Strength of Brickwork*

Following is a list of the factors which, through study of the experiments mentioned in Par. 9, it is possible to evaluate:

1. Characteristics of individual brick
2. Mortar, materials and proportions
3. Slenderness ratio of wall or pier
4. Bond and jointing
5. Workmanship
6. Age of masonry
7. Manner of loading

Strength of Individual Brick: Practically all the test series studied indicate that, other conditions being equal, the compressive strength of clay brick masonry is proportionate to that of single brick. This does not hold true, however, for brick of the lowest grades recognized by the American Society for Testing Materials standards. Recent experiments seem to indicate that the ratio of wall strength to brick strength is considerably greater for clay brick of low compressive strength.

Exhaustive experiments both at Columbia University (see item 16, par. 9), and at the Bureau of Standards indicate that concrete brick averaging from 1,500 to 2,500 pounds per square inch compressive strength will make a wall about as strong as one of clay brick averaging 3,000 to 5,000 pounds per square inch. Further investigations may throw more light on this point.

There either are not sufficient comparable data on the ratio between modulus of rupture of single brick and the compressive strength of piers by which to establish a relation, or else the variations are so wide that no very definite ratio can be said to exist. Both from a theoretical point of view and for practical enforcement reasons, it seems that the crushing strength is a better criterion of the utility of brick than the modulus of rupture. No attempt therefore has been made to base working stresses on requirements as to the modulus of rupture of brick.

Mortar, Materials and Proportions: Customs in regard to the composition and proportions of mortar vary in different localities, but it was considered by the Committee that sufficient guidance to those drafting building codes would be afforded if recommendations were made for four types of mortar, proportioned by volume, as follows:

1 part Portland cement to 3 parts sand, with permissible addition of lime not to exceed 15 per cent of the cement

1 part natural cement to 3 parts sand

1 part Portland cement, 1 part lime, and 6 parts sand

1 part lime to 4 parts sand

Investigation of the test series on record shows that with conditions otherwise equal, the strength of masonry laid with 1-3 or ¼ lime mortar did not in any case average more than 70 per cent of that laid with Portland cement mortar, and in certain cases fell as low as 30 per cent. In assigning lime masonry a limit equal to one-half that for cement mortar masonry, the Committee is influenced rather by long experience with its successful use under moderate loading than its performance in comparative tests. Lime mortar is known to attain its final strength more slowly than cement mortar, and tests at an early date do not in all cases indicate its final bearing strength. Masonry in a building, on the other hand, may be loaded to full capacity within two or three months and dependence on possible future strength is unjustifiable.

The data available indicate that masonry built with cement-lime mortar, as defined in Part II, varies in strength from 70 to 85 per cent of that laid with cement mortar to which a small percentage of lime has been added. The limits on working stresses therefore have been placed tentatively at 80 per cent of those for cement mortar masonry. There are no data available on the strength of masonry laid with natural cement mortar in which the cement is known to have complied with A. S. T. M. specifications.

Slenderness Ratio: Neither observation of the behavior of masonry under practical conditions nor study of comparative test records indicates that the strength of masonry walls is affected to any extent by increases of the slenderness ratio between 4 and 20.

Bond and Jointing: There is no evidence to show that within the limits set in Part II the frequency of headers affects the strength of masonry. The limit is based on standards of general practice rather than on experimental investigations. Special bonding stones or wire mesh between courses have proved ineffective unless placed in every course, when they improve the strength considerably. For load-bearing masonry, joints should preferably be as thin as is consistent with full bedding of the brick, but they apparently may be as much as ½-inch without affecting compressive strength.

Workmanship: The recommendations of Part II are based on the understanding that supervision or inspection will be such as to ensure good workmanship and utilization of materials.

The following suggestions as to what should be considered good practice in brick work have been received from various authorities on the subject:

Care should be taken to ensure even and complete bedding of the masonry units, and joints should be of sufficient thickness to permit this. Vertical joints of exterior face courses should be buttered and bricks carefully shoved to place. Mortar should not be placed on the beds with a shovel or from the hod, but may, if desired, be placed with special spreading devices. End joints of interior face courses should also be carefully filled if the wall is to be furred.

Where dryness and general serviceability are more important in brick work than compressive strength, no particular attempt to fill interior vertical joints by shoving is necessary.

During warm and dry weather all brick should be thoroughly wet just previous to being laid, in order that a good bond may be obtained between brick and mortar, and so that sufficient water will be left in the mortar to permit its acquiring full set.

It is common practice in our northern cities to build upon frozen brickwork, but if long continued low temperatures ensue, precautions against injury and overloading must be observed, and special care should be taken if brickwork is subjected to alternate freezing and thawing. Brick should be thoroughly dry when laid in cold weather, and for best results both bricks and mortar should be warm, so that the latter may obtain at least a partial set before it is frozen.

Reference to the retempering of mortar, commonly forbidden in codes and specifications, has been omitted, as the Committee has no evidence to prove that retempered mortar is inferior to fresh mortar. Remarks from those who have had experience with the use of

retempered mortar will be welcomed by the Committee.

Age of Masonry: Working stress requirements, and, in fact, all recommendations of Part II, are based on the assumption that brick masonry is not unlikely to be loaded within a period of two months to the full extent contemplated in the design. No provision is made in the recommended working stresses for construction loads, as it is considered that builders should not be penalized to provide insurance against careless construction practice. It is doubtful if reduction in working stresses for this reason would be effective if made.

Manner of Loading: Experimental data indicate a sharp decrease in bearing capacity when loading is eccentric, and where this occurs in actual practice the average working stress should be decreased sufficiently to keep the combined fiber stress within the prescribed limit.

Par. 12. *Factors of Safety for Brickwork*

Interpretation of test data on compressive strength of walls and piers, to establish working stress requirements, depends on whether the ultimate compressive strength, or that at which cracks, snapping sounds, etc., begin to be perceptible, is chosen as a basis for the factor of safety. Certain experiments indicate that loads causing initial signs of failure, if often repeated or long continued, result in total failure. Stress causing total failure, on the other hand, has been generally used in ariving at allowable working stresses, and for this reason and those following, the Committee has applied the factor of safety to the maximum stress:

1. In individual cases the relation between stress causing initial signs of failure and the maximum is uncertain. Stresses causing snapping and cracking differ more widely among piers of the same type than do maximum stresses.
2. It is more difficult to report initial signs of failure accurately than to record maximum stress.
3. There is at least a question whether cracking and snapping of test specimens really means that failure is beginning or whether it is merely an adjustment to load which is without particular significance.
4. Examination of a large number of representative tests indicates that the average of stresses at which cracking and snapping occurs bears a fairly uniform ratio to the maximum.

It has been customary in code practice to consider that established stress limits represented a "factor of safety" of 10, based on crushing strength of the units used in the wall or pier. This is unlike practice with other materials, such as steel, concrete and lumber, where the test value is for the entire member rather than for the units comprising it. If, in masonry, the factor were applied to the wall or pier as a whole, it would be comparable to the factor used with other materials and would be much less than 10.

A factor of safety should be increased as the number or weight is unregulated or uncontrollable elements affecting the strength of a material increase. Conversely, as conditions of use and standards of quality are more closely defined, the factor of safety may be reduced. There has been some attempt in the past to regulate quality of brick, but for the most part it appears that factors of safety for brick masonry have existed rather in fictitious floor loads and in empirical thickness requirements, than in a margin of compressive strength over permissible working stresses. Certain occupancies, especially warehouses, support their full assumed live loads, but in most cases brick walls are never subjected to the loads they are assumed to carry.

In arriving at its recommendations for maximum working stresses, the Committee has had reference both to a careful investigation of test data bearing on the subject and to successful practice in cities such as New York and Boston, where the quality of materials and the conditions of use are known to have been fairly well controlled.

Experimental Data: From the series listed in Par. 9, Part III, 60 tests were selected which come within the general limitations laid down in Part II for load-bearing masonry of clay brick laid with cement or cement-lime mortar. In all cases the ultimate strength of these test specimens was greater than 7 per cent of the crushing strength of brick used in their construction. The average ratio was 18 per cent, and the maximum 43 per cent. There were four cases in which the ratio was less than 10 per cent, and six in which it was over 30 per cent. The average stress at which cracking sounds, spalls, etc., first appeared was approximately 10 per cent of the strength of individual brick.

To show the possibility of strength variation of piers built of the same grade of materials under similar conditions by the same workmen, eighty-five groups were selected, alike in all particulars so far as could be discovered from the reports. The maximum individual variation from the average strength of each group was computed and was found to be less than 25 per cent in all except four cases, which ranged from 27 to 35 per cent. In 42 groups the variation was less than 10 per cent. Variations above and below the average were about equally balanced.

The experiments covered by the preceding two paragraphs were all upon masonry piers. Comparison of results from the tests of masonry walls, see Item 18, Par. 9, show that variations in strength between similar specimens and variations in the ratio of wall strength to strength of individual brick are as great for walls as for piers and indicate that the influence of workmanship and of variation in strength of materials is not necessarily compensating throughout the length of the wall.

The Committee holds that these results, while perhaps indicating desirability of lower stresses than permitted by Part II, are of minor importance in comparison with observed successful practice in cities where such stresses have been permitted by codes, and has adopted a factor of safety of about 1.8 based on the average stress at which failure may be expected.

Par. 13.

An investigation of typical residential and commercial buildings, eight stories in height, designed for 18-foot floor spans, and for uniform live loads of 40 to 150 pounds per square foot respectively, shows that the compressive stresses in bearing walls of the minimum thicknesses permitted by Part II will not exceed 100 pounds per square inch over the full section at the first floor line for residential occupancy, and 150 pounds per square inch for commercial occupancy. For walls built throughout with 50 per cent of openings in each story, the corresponding stresses in the first story will be 150 and 250 pounds per square inch. This presupposes that the full live loads assumed will be present, a condition which seldom actually obtains. It appears, therefore, that except in the case of specially heavy occupancies of buildings with a large window area the thickness requirements dictated by stability considerations will govern, rather than those established by working stress limits.

Par. 14. *Thickness of Brick Walls*

The difference in treatment of residential and commercial buildings less than 30 feet in height is based on the results of a series of questionnaires, submitted to fire chiefs, insurance rating organizations, and building inspectors. These returns may be summarized as follows:

Building Inspectors: Of about 80 building inspectors who expressed their opinions on this subject, 75 per cent approved the use of 8-inch walls for two-story residence buildings, and 15 per cent considered them adequate for three-story buildings. In both cases the replies were concerned only with one- and two-family dwellings. For light commercial occupancies 7 respondents only would allow 8-inch walls up to 3 stories, 30 would permit them 2 stories in height, and 14 would confine them to one story. Thirteen inspectors consider that commercial occupancies demand a 12-inch wall under all circumstances, 5 would make the first story of a 3-story commercial structure 12 inches; and 2 would require the lower two stories to be 12 inches or thicker.

Insurance Organizations: Through their experience in adjusting claims, these have much data on the relative stability of 8- and 12-inch walls, as affected by fires. The consensus of opinion among the 37 reports received strongly supported the 12-inch wall as having greater resistance to bulging and collapsing under heat effects; against damage from falling timbers; and as providing a superior fire-stop between buildings. Its salvage value also is greater, though this, of course, is an item with which a building code is not concerned.

Fire Chiefs and Fire Marshals: Practically all of the 55 respondents experienced in fire-fighting both with 8-inch and 12-inch walls, favor the latter as less likely to collapse under a hot fire or the action of floor beams, with resultant danger to firemen.

In view of the above consensus of opinion and of

considerations elsewhere mentioned, and of the heavier floor loads and hotter fires to be expected in commercial buildings, the Committee decided to limit 8-inch walls to one story. It was held, however, that while the questionnaire mentioned was confined to one- and two-family dwellings there is not sufficient difference between these and tenements, lodging-houses, etc., not more than three stories in height, to warrant a requirement for thicker walls.

In permitting the same minimum wall thicknesses for commercial or industrial buildings as for the larger residential buildings, the Committee had reference to the following considerations:

1. Occupancies which involve vibration likely to affect wall stability will in practically all cases involve live loads which necessitate a wall thicker than the minimum.

2. The effects of even the hottest fires on 12- and 16-inch solid brick walls were shown by the Bureau of Standards tests to be negligible as regards transfer of heat through the walls.

3. Heavier floor loads, where not exceeding the allowable unit stresses, increase the vertical components of the applied pressure and add to the stability of walls against lateral forces, thereby giving the industrial building an advantage as compared to the residential building.

4. Within the economic height limits of buildings with brick bearing walls the industrial or commercial building is more apt to have a rigid interior framework than the residential building.

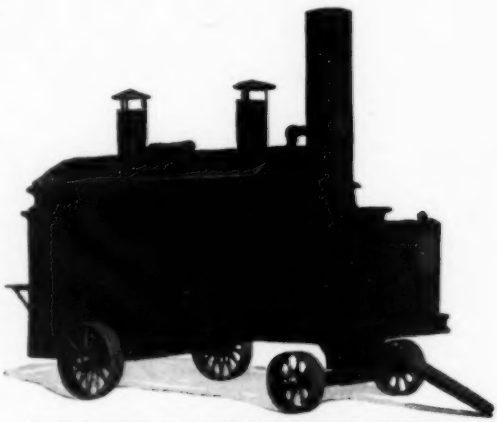
In arriving at the minimum wall thicknesses prescribed in Part II, the Committee had in mind the usual heights to which bearing walls are erected under present economic conditions. When such walls are used for buildings over 8 stories in height, special conditions may affect considerably the desirable thickness, and competent professional authority should be consulted.

(To be concluded in the May issue)

A New Asphalt-Producing Plant

Portable Outfit a Great Help to Contractors and Highway Officials

CONTRACTORS and highway officials doing a considerable amount of asphalt work will find the Littleford-Pullar asphalt-producing plant of special interest. This plant is a complete unit in itself and produces any kind of asphalt from flux oil. It is capable of producing asphalt for penetration work, asphalt cement for asphaltic concrete or sheet-asphalt streets, and asphalt filler for brick work. The plant has been under practical test during the past year, and has met with all standard specifications in from four to six hours, which is fully as quick as solid filler can be melted. It is said that the saving in cost to the contractor is a considerable item. Asphalt cement for penetration asphalt can be produced in less time, and so made as to meet any of the standard specifications, thus making it necessary to keep on hand only the flux oil instead of the various types of asphalt necessary for different kinds of work. The plant and method of producing asphalt are so simple that one man is capable of taking care of the entire operation of the plant.



FRONT VIEW OF ASPHALT-BLOWING MACHINE

This Littleford-Pullar plant was designed by H. B. Pullar, Manager of the Flux and Road Oil Department of the Indian Refining Company, Lawrenceville, Ill. Mr. Pullar is one of the early advocates of blown asphalts and has been intimately associated with the production of this class of asphalt for the last fifteen years. He has designed and acted in a consulting capacity for some of the largest asphalt-blowing plants in the country. The simplicity and practicability of this new portable asphalt-producing plant are the result of years of experience in trying to find a practical solution of the economical and efficient production of asphalt on the job. Littleford Brothers, 500 East Pearl Street, Cincinnati, Ohio, have the exclusive manufacturing rights for the plant and will distribute it through their own sales organization.

Gases in Street Manholes

ATMOSPHERES in telephone manholes in Philadelphia have been examined for the presence of carbon monoxide by the Department of the Interior, acting through the Bureau of Mines. The Hoolamite detector and a newly devised bomb tester for explosive gases were used. The bomb is made of pipe fittings, spark plug, automobile spark coil and dry cells. Of 13 manholes in different parts of the city, suspected of being gaseous, 12 contained irrespirable atmosphere, and two of these were explosive. Eleven holes were tested at random and 8 showed dangerous quantities of carbon monoxide. Workmen at Philadelphia ventilate gaseous manholes before entering, with sails or a rotary hand-driven blower.

INSLEY CONCRETE PLACING EQUIPMENT

WHERE LARGE jobs are being carried forward by leading contractors INSLEY EQUIPMENT will be found.

In constructing the Big Four Railroad's Concrete Bridge across Great Miami River at Sidney, Ohio, the Walsh Construction Co. used INSLEY STEEL TOWER, QUICK SHIFT, COUNTERWEIGHT CHUTE EQUIPMENT for placing their concrete, and obtained results heretofore considered almost impossible.

There is an arrangement of chuting suited for the majority of concrete jobs, and Insley Service, indicating just what this is, is yours for the asking.

INSLEY MANUFACTURING COMPANY

Engineers and Manufacturers

INDIANAPOLIS

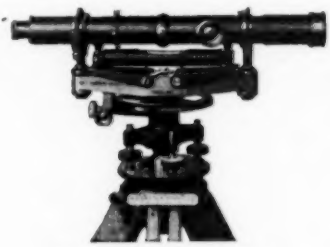
Make Building Methods Less Primitive

A Convertible Level and Transit a Great Aid to Building Contractors

AN editorial appearing in a recent issue of *Engineering News-Record* states that "there has been less development of the small labor-saving machine in engineering construction than is to the credit of either the constructor or the equipment manufacturer. Equipment for mass operations, such as the steam shovel and concrete mixer, has been advanced far in mechanical perfection and in employment. So have special machines like the trench excavator and paving mixer. It is in machines for individually small operations that development has lagged. Building construction which is pronounced by a series of non-continuous processes of great variety furnishes a particularly good example. Except for the high development of pneumatic tools in steel erection, we find very few light-task and labor-saving machines used. Carpentry, plastering and painting are most commonly hand operations on large buildings and are always manually performed in residence and other small building work. . . . All of the backwardness does not, however, lie with the equipment manufacturer. Neither the contractor nor the artisan has progressed much beyond primitive thought in conducting many building operations."

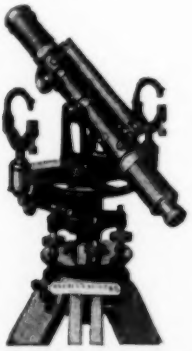
PROCESS OF CHANGING FROM A LEVEL TO A TRANSIT HALF COMPLETED

J. O. Preston, of the Warren-Knight Company, Philadelphia, Pa., says: "On the majority of small building operations you will see time lost and costly errors made because a level-board and string are being used instead of a surveying instrument, such as the convertible level or transit. There are several comparatively low-priced yet reliable instruments on the market at convenient terms to aid the small builder in establishing accurate lines and levels quickly. The cause for the general backwardness in the development of machines for individually small operations is the atmosphere of 'doing' in which the builder lives as compared to an atmosphere of 'planning.' He can be criticized more fairly for being too 'practical,' and he is justified in claiming the engineer to be too 'theoretical.' Since the builder is so engrossed in rushing around on a job in actual operation or is hunting for more contracts, perhaps it would pay him to increase his overhead to the extent of securing the services of an engineer who could reduce operating costs by utilizing such equipment as is now available."



INSTRUMENT MOUNTED AS A LEVEL

A new Model 40 Sterling convertible level has recently been brought out by the Warren-Knight Company, 136 North 12th Street, Philadelphia, Pa., to fill the needs of builders. This level can be converted for use as a transit in 10 seconds, and back again as quickly, without jarring the instrument out of level. It has a 13½-inch telescope with no projections to obstruct free sighting or prevent its being rotated in its wyes. It has a high-power lense showing objects clearly at long distance and as close as 5 feet. The leveling head is strongly ribbed and non-cramping, giving a maximum speed of leveling and minimum wear on the



INSTRUMENT MOUNTED FOR USE AS A TRANSIT

Warford the Road Builder

"We cannot speak too highly of the Warford Transmission, for we feel that it is really the making of the Ford Truck."
John C. McCusick,
McCusick Contracting Co., Minneapolis

Warford, the selective type transmission for Ford Cars and Trucks, proved in the gruelling test of road building, has made the Ford Truck the favorite of highway contractors throughout the county.

Conspicuous service at road building, the toughest job of them all, is being given by Warford equipped Fords over the breath-taking grades of Colorado, the plains of Iowa and in the fickle climate of Michigan where the contractor gambles with the weather. The speed that Warford gives the Ford insures his profit.

Letters from the Michigan camps, in the very heart of the automotive industry where the newest wrinkles in car and truck engineering are brought forth and tested, are unanimous in praise of the added pulling power, added speed and greater economy of operation and maintenance that the Warford Transmission has given the Ford Truck. These letters stand confirmed by repeat orders.

With Warford, the Ford Truck pulls a full two tons through the roughest going. It won't stall in the subgrade. It is guaranteed to pull this double load wherever there is traction. On hard roads Warford makes your Ford a speed truck.

Warford gives you this double duty unit at one third the cost of any other two-ton or speed truck. Ask your Ford dealer or write us.

Warford
AUXILIARY TRANSMISSION

The Warford Corporation - - 44 Whitehall St., New York

leveling screws, which are provided with permanently attached ball-socket shoes. The shifting plate makes it possible to shift the entire instrument ¾-inch on the tripod for quickly and accurately setting up exactly over any given point.

The patented convertible device is self-contained and consists of two permanently attached hinged uprights for converting the instrument for use as a transit with a range of over 45 degrees of elevation or depression in the vertical plane. A single movement of an ingenious lock lever secures the upright and telescope in perfect vertical alignment. Spring tension trunnion clips frictionally hold the telescope at any desired slant. When not in use the uprights may be folded down against the level-bar, affording full view of the level vial and permitting the telescope to be revolved freely in the wyes.

A New Model Steam Shovel With Front Crawler

Three Months' Trial in Many Parts of the Country Shows Value of New Equipment

CONTRACTORS who have used Keystone shovels will doubtless be interested to know that the Keystone Driller Company, Beaver Falls, Pa., is bringing out its 1924 Model 4 with half-crawler mounting. This machine weighs 15 tons as a wheel traction outfit, and 16 tons mounted on front crawlers. It is regularly equipped with a 40- x 86-inch boiler, either vertical fire-tube or cross-tubular type. On the front-crawler machine the sills

VIEW OF MODEL 4 KEYSTONE CRAWLER EQUIPPED WITH SKIMMER BUCKET

FRONT VIEW OF KEYSTONE EXCAVATOR EQUIPPED WITH CRAWLER TREAD

are extended 30 inches to accommodate the steering wheel at the boiler end. This machine is also furnished with an electric-motor or gas-engine drive to suit the convenience of the purchaser.

This job includes drop-bottom, pull-stroke, ditcher-bucket equipment. The bottom of this type of bucket is hinged at the teeth and latched at the outer end. When the bottom is dropped, it swings far enough on its hinge axis to aid in expelling any material which may be stuck in the bucket and in cleaning the sides. The bucket is made in seven widths—14, 18, 24, 30, 36, 42 and 54 inches. Even the narrowest widths are said to be self-cleaning in sticky materials.

The ⅝-yard skimmer bucket has an exceptionally long horizontal crowd—14 feet—which renders it particularly adaptable to street and road excavation. The buckets are not expensive and it is possible to change from one to the other in a few minutes' time. By use of a boom extension, it can be arranged to handle a half-yard clam-shell bucket when this type of excavator will serve better.

The crawler tread is mounted under the digging end of the machine, which of course is subject to the greatest weight, strains and digging stresses. So equipped, the machine can be operated over any material of sufficient stability to carry crawler traction. This greatly increases the stability of the machine as well as its field of action.

T. M. WHITE CO.
Excavating and Wrecking
CHICAGO, ILLINOIS

The Heil Co., Chicago, Ill.

Gentlemen:—

We are pleased to advise that the thirteen Hydro Dumping Units, mounted on Mack, Old Reliable and White trucks, have been operating two years on excavation work. We find that the hoist has a tremendous lot of power and gives a very big degree of angle when fully raised.

Since we drop our tail gates from the top, it is necessary to have a high ground clearance, and with this equipment it well takes care of our work. Our service and upkeep cost has been very low.

Yours very truly
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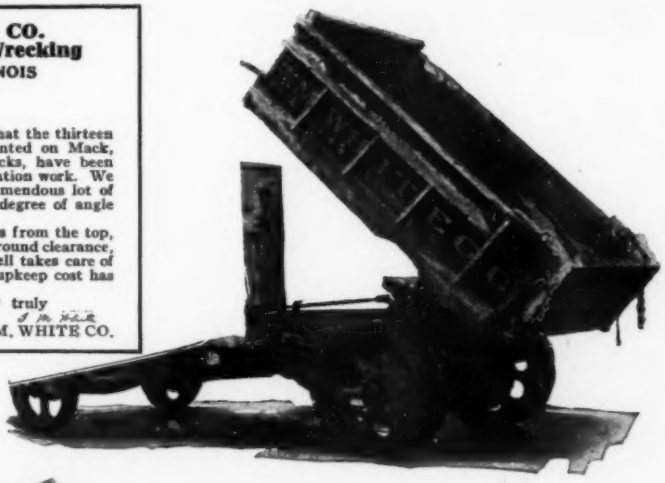

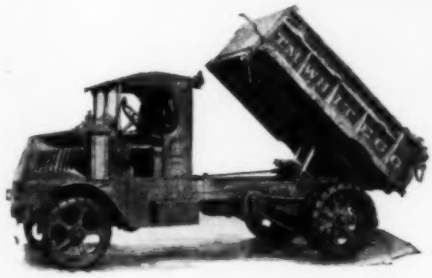

Our Customer Speaks for Us!

T. M. White, in his interesting letter, tells you 5 important advantages about his Hydro Hoists. They are:

1. A tremendous lot of power.
2. A very big degree of dump angle.
3. High ground clearance.
4. "Our Service cost has been very low."
5. "Our up-keep cost has been very low."

Remember, T. M. White's work is the most exacting for dumping equipment. It takes a mighty good body and hoist to stand up under the steady strain of steam shovel loading. Heil equipped T. M. White's fleet. How about yours?

Write for Bulletin 131

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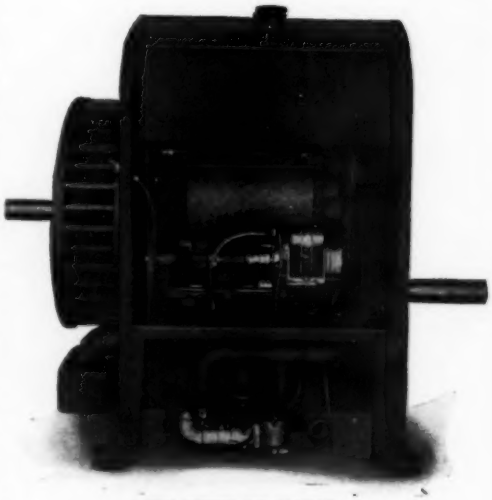
A New Type of Internal-Combustion Engine

Shown to Contractors and Engineers for First Time at the Road Show

AN unusual amount of interest was displayed in a new type of internal combustion engine known ts the Denison Power-maker, which was displayed at the Good Roads Show in Chicago in January. This engine was designed especially for contractors' equipment and has proved very successful in European countries. It is an inverted 2-cylinder, 4-cycle, water-coled engine entirely housed in a 16-gage pressed-steel casing. The cylinders, bearing standards and base are all included in one casting, which makes the unit very rigid, with permanent and proper alignment of piston, crank-shaft and cam-shaft. This also lowers the center of gravity of the entire unit. The crank-shaft, cam-shaft, magneto governor assembly, and also the connecting rods, are located on top of the main base casting and are very accessible, so that adjustments can be quickly and easily made.

The valve-box, which includes the valve intake and exhaust manifold and carburetor, can be quickly and easily removed by taking out six machine bolts.



SIDE VIEW OF MOTOR

END CUTAWAY VIEW OF NEW GASOLINE ENGINE WITH THE CRANK-SHAFT ON TOP

Cooling water from the radiator upon entering the cylinder block strokes the cylinder head, which is the hottest part of the unit and rises as it is heated, producing rapid water circulation and uniform cooling. Air is drawn through the radiator, which is mounted at the rear of the main casting, by a fly-wheel, sirocco-type fan. The radiator is shrouded so that the dust and dirt blowing through it in the air does not come in contract with any part of the working mechanism.

The fuel tank is located at the top of the housing. Access to the working parts and the valve-box compartment is effected by removing the front cover, which is a 16-gage pressed-steel piece and can be locked in place, making it impossible to tinker with the mechanism. The Cook Motor Company, Delaware, Ohio, manufacturer of this new type of engine, claims that the inverted cylinder construction eliminates crank-case oil-dilution, which is a great problem with the automobile type of motor. The inverted construction enables this engine to be operated on kerosene, as well as gasoline. Power can be taken from the crank-shaft at a speed ranging from 500 to 1,200 revolutions per minute, and from the gear-reduction shafts at speeds ranging from 250 to 600 revolutions per minute, securing a power range of from 5 to 12 horse-power from either shaft.

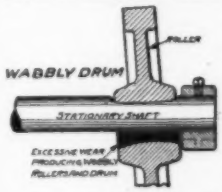
KOEHRING

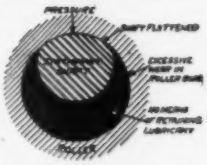
Consider Bearings First

WORN bearings mean vibration — crystallization — disalignments, strains and breakages in *every part of the whole machine.*

The service life of any machine is first of all in the bearings—especially in the drum rollers of a mixer which get continuous service under heavy, shifting loads. Bearings must be right in principle or they can not be right in practice.

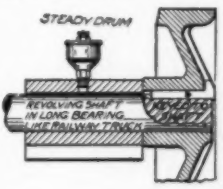
The Koehring drum roller bearing is the type accepted by engineers as best for heavy duty service—the same as used on freight car trucks. And Koehring heavy duty construction makes them liberally — generously— oversize — one of the fundamental reasons for Koehring long service life and remarkable freedom from breakdowns and delays.



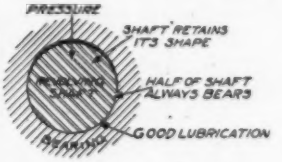


CUT at left shows a "line" type of bearing—the revolving unit always turning on a fixed or stationary axle. The cut at the right shows the characteristic wear that results when this type is applied to drum rollers. The down-thrust of the heavy drum brings all the wear on the top side of the fixed axle, flattening it. The end-to-end thrust of materials, tumbling inside the drum, wears the outside edges of the roller openings. Even a slight amount of wear allows rollers to wabble, causing disalignment, pounding, vibration and strain throughout the mixer—the principal causes of breakage everywhere.

The right hand cut also shows clearly how this wear on the line bearings *prevents* lubrication. Enlargement of the roller opening soon leaves a considerable space between the lower side of the fixed shaft and the roller. Lubrication is squeezed down and pocketed. The heavy thrust on the top side of the shaft prevents adequate lubrication staying between the fixed axle and revolving roller.



THIS is the Koehring type—the roller *fixed to the shaft and the shaft turning in oversize, adjustable shimmed bearings accessible on main frame.*



At the right is shown how the Koehring revolving shaft always carries the load on the full face of the fully lubricated bearings.

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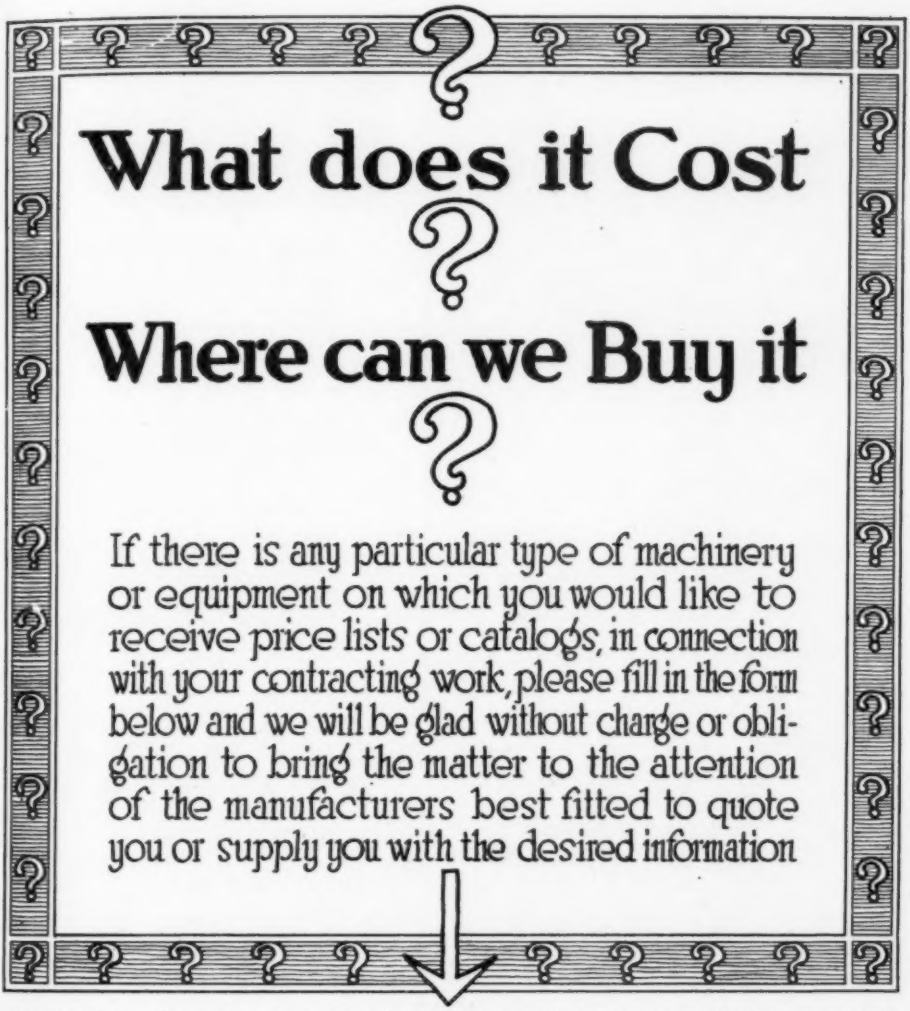

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